ARM-95-002

Site Scientific Mission Plan for the Southern Great Plains CART Site

July-December 1995

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Environmental Research Division
Argonne National Laboratory
Argonne, IL 60439

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Michael E. Splitt and Peter J. Lamb
Cooperative Institute for Mesoscale Meteorological Studies
The University of Oklahoma
Norman, Oklahoma 73019

and

Douglas L. Sisterson
Environmental Research Division
Argonne National Laboratory
Argonne, Illinois 60439

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NOTATION

AERI	atmospherically emitted radiance interferometer
ANL	Argonne National Laboratory
ARESE	ARM Enhanced Shortwave Experiment
ARM	Atmospheric Radiation Measurement
ARM BSRN	ARM Program Broadband Solar Radiation Network
ARS	Agriculture Research Service
AVHRR	advanced very-high-resolution radiometer
BBSS	balloon-borne sounding system
BLC	Belfort laser ceilometer
CART	Cloud and Radiation Testbed
CASES	Cooperative Atmosphere-Surface Exchange Site
CCN	cloud condensation nuclei
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies
CSIRO	Commonwealth Scientific and Industrial Research Program
CSU	Colorado State University
DA	data assimilation
DMT	Data Management Team
DSIT	Data and Science Integration Team
EBBR	energy balance Bowen ratio
ECOR	eddy correlation
EML	Environmental Measurements Laboratory
EOP	experiment operations plan
EOS	Earth Observing System
ERL	Environmental Research Laboratories
EST	Experiment Support Team
ETL	Environmental Technology Laboratory
FDDA	four-dimensional data assimilation
FTP	File Transfer Protocol
GBRS	Ground-Based Remote Sensing (IOP)
GCIP	GEWEX Continental-Scale International Project
GCM	general circulation model
GCSS	GEWEX Cloud System Study
GEWEX	Global Energy and Water Cycle Experiment
GIST	GEWEX Integrated System Test
GMS	general measurement strategy
GOES	geostationary orbiting Earth satellite
GPS	global positioning system
GSFC	Goddard Space Flight Center
GVaP	GEWEX Water Vapor Project
HD	hierarchical diagnosis
IDP	Instrument Development Program
IOP	Intensive Observation Period
IR	infrared
IRF	instantaneous radiative flux

NOTATION (Cont.)

ISLSCP	International Satellite Land-Surface Climatology Project
ISS	integrated sounding system
IT	Instrument Team
LBLRTM	line-by-line radiative transfer model
MAPS	Mesoscale Analysis and Prediction System
MFR	multifilter radiometer
MFRSR	multifilter rotating shadowband radiometer
MPL	micropulse lidar
MSX	midcourse satellite experiment
MWR	microwave radiometer
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCSU	North Carolina State University
NEPA	National Environmental Policy Act
NIP	normal-incidence pyrheliometer
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OCS	Oklahoma Climate Survey
ORR	Operational Readiness Review
PAR	photosynthetically active radiometer
PARC	Palo Alto Research Center
PBL	planetary boundary layer
PC	personal computer
PNL	Pacific Northwest Laboratory
PRR	Pre-Readiness Review
PSU	Pennsylvania State University
QME	quality measurement experiment
RASS	radio acoustic sounding system
RCF	radiometer calibration facility
S	solar
SAC	Site Advisory Committee
SCM	single-column model
SDS	site data system
SEE	Surface Energy Exchange
SGP	Southern Great Plains
SIROS	solar and infrared radiation observing system
SMOS	surface meteorological observation station
SNL	Sandia National Laboratories
SORTI	solar radiance transmission interferometer
SOW	statement of work
SPM	site program manager

NOTATION (Cont.)

SST	Site Scientist Team
SUNY	State University of New York
TBD	to be determined
TOA	top of atmosphere
UAV	unmanned aerospace vehicle
UM	University of Massachusetts
UNAVCO	University NAVSTAR Consortium
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
UTC	universal time coordinated
UU	University of Utah
UV	ultraviolet
UW	University of Wisconsin
VISSR	visible-IR spin-scan radiometer
VORTEX	Verification of the Origins of Rotation in Tornadoes Experiment
WPL	Wave Propagation Laboratory
WSI	whole-sky imager
WVMR	water vapor mixing ratio
2-D	two-dimensional
3-D	three-dimensional

SITE SCIENTIFIC MISSION PLAN
FOR THE SOUTHERN GREAT PLAINS CART SITE
JULY-DECEMBER 1995

1 INTRODUCTION

The Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site is designed to help satisfy the data needs of the Atmospheric Radiation Measurement (ARM) Program Science Team. This document defines the scientific priorities for site activities during the six months beginning on July 1, 1995, and looks forward in lesser detail to subsequent six-month periods. The primary purpose of this *Site Scientific Mission Plan* is to provide guidance for the development of plans for site operations. It also provides information on current plans to the ARM functional teams (Management Team, Data and Science Integration Team [DSIT], Operations Team, Instrument Team [IT], and Campaign Team) and serves to disseminate the plans more generally within the ARM Program and among the members of the Science Team. The former Experiment Support Team (EST) and Data Management Team (DMT) were recently integrated into one functional team, the DSIT. This document includes a description of the operational status of the site and the primary envisioned site activities, together with information concerning approved and proposed Intensive Observation Periods (IOPs). The primary users of this document are the site operator, the Site Scientist Team (SST), the Science Team through the ARM Program science director, the ARM Program Experiment Center, and the aforementioned ARM Program functional teams. This plan is a living document that will be updated and reissued every six months as the observational facilities are developed, tested, and augmented and as priorities are adjusted in response to developments in scientific planning and understanding.

2 SUMMARY OF SCIENTIFIC GOALS

2.1 Programmatic Goals

The primary goal of the SGP CART site activities is to produce data adequate to support significant research addressing the objectives of the ARM Program. These overall objectives, as paraphrased from the *ARM Program Plan, 1990* (U.S. Department of Energy 1990), are the following:

- To describe the radiative energy flux profile of the clear and cloudy atmosphere

- To understand the processes determining the flux profile

- To parameterize the processes determining the flux profile for incorporation into general circulation models

To address these scientific issues, an empirical data set must be developed that includes observations of the evolution of the radiative state of the column of air over the central facility, as well as the processes that control that radiative state, in sufficient detail and quality to support the investigations proposed by the ARM Science Team. To address the entire 350-km × 400-km SGP CART site, ARM relies on models to compute the processes or properties that affect radiative transfer. This set of data includes measurements of radiative fluxes (solar and infrared [IR]) and the advective and surface fluxes of moisture, heat, and momentum occurring within the column and across its boundaries. Other entities to be described are cloud types, composition, and distribution (depth, fractional coverage, and layering); thermodynamic properties of the columnar air mass (temperature, pressure, and concentrations of all three phases of water); the state and characteristics of the underlying surface (the lower boundary condition); processes within the column that create or modify all of these characteristics (including precipitation, evaporation, and the generation of condensation nuclei); and radiatively significant particles, aerosols, and gases. Basic continuous observations must be made as often as is feasible within budgetary constraints. For limited periods of time, these observations will be supplemented by directed IOPs providing higher resolution or difficult-to-obtain *in situ* data.

Beyond simply providing the data streams, determining their character and quality as early as possible in the observational program is imperative. This evaluation will provide the basic operational understanding of the data necessary for an ongoing program of such scope. Although both reason and ample opportunity will exist to develop a further understanding of the ARM observations over the course of the program, the task of investigating and ensuring the data quality as soon as possible is important. In this regard, early and definitive quality measurement experiments (QMEs) will establish confidence in the measurements.

The SGP CART site is the first of several global locations chosen and instrumented for data collection. As summarized in a draft report by Sisterson and Barr, the scientific issues to be addressed by using data from a midlatitude continental CART observatory include the following:

- Radiative transfer in cloudless, partly cloudy, and overcast conditions

- Cloud formation, maintenance, and dissipation

- Nonradiative flux parameterizations

- The role of surface physical and vegetative properties in the column energy balance

- Other complications in the radiative balance in the atmosphere, particularly those due to aerosols, cloud condensation nuclei (CCN), and cloud-aerosol radiative interactions

- Feedback processes between different phenomena and different domains

The variety, surface density, and atmospheric volumetric coverage of the SGP instrumentation will be more comprehensive than that at any other ARM site, and the SGP site will experience a wider variety of atmospheric conditions than will any other ARM site. The resulting data will accordingly support a greater range and depth of scientific investigation than data from any other location, making it imperative for the ARM Program to develop and maintain a high-quality, continuous data stream from the SGP site.

The measurements required by Science Team proposals, the DSIT, and the science director are incorporated into a set of general measurement strategies (GMSs) representing groups of experiments requiring measurements with similar characteristics. The initial GMSs are designed to quantify the instantaneous radiative flux (IRF) and to support the requirements of the single-column model (SCM), data assimilation (DA), and hierarchical diagnosis (HD) research. The DSIT and other teams are coordinating activities to develop integrated, well-focused data sets. This six-month period will include activities to support research from each of the GMSs.

2.2 Priorities for Site Activities

The primary scientific goal has shifted from the establishment of routine observations to addressing the site-specific science issues related to the SGP CART site. In descending order, we rank the priorities of site activities for July through December 1995 as follows:

1. Plan and implement key IOPs.

2. Complete establishment of routine site operations.

3. Support all data quality assurance efforts, including implementation of QMEs.

4. Support the Instrument Development Program (IDP).

5. Plan and implement campaigns.

Within this ranking, the differences in relative importance between adjacent items are not large. The categorization is also somewhat artificial, because many site activities are multipurpose. For example, IOP activities can simultaneously support Science Team, IDP, and campaign requirements. Even so, this ranking reflects our scientific assessment of the activities that should receive the most support during this period.

The IOPs will focus on providing critical data sets on an episodic basis to the Science Team, as well as field support for instrument development and testing and for collaborative campaigns. The IOPs scheduled for this six-month period are detailed in Section 4. To assist the site scientist with scientific issues, the ARM Program has approved a Site Advisory Committee (SAC) consisting of seven scientists, approximately half from outside the ARM Program, to provide quick-turnaround scientific guidance for the SGP CART site. The SAC will work with the site scientist and the site program manager.

Budgetary constraints and site scientific issues have forced management of the SGP CART site to continually reevaluate the radiosonde launch schedule. The cost of radiosondes is the single largest expense for the SGP CART site. Routine radiosonde observations will continue to include five daily balloon-borne sounding system (BBSS) launches on Monday through Friday (including holidays) at the central facility. One routine daily launch will continue on Monday through Friday (including holidays) at the four boundary facilities. Three SCM IOPs, each lasting for three weeks, are now conducted each year; a summer SCM IOP is scheduled during July 1995. Three SCM IOPs will continue to be scheduled each year. The spring and summer SCM IOPs are scheduled annually, but the fall and winter SCM IOPs alternate between years. Because a fall SCM IOP occurred in 1994, a winter SCM IOP is scheduled for January 1996. The ARM Enhanced Shortwave Experiment (ARESE) IOP will include an enhanced radiosonde launch schedule at both the central and boundary facilities, at a launch frequency of eight per day at each facility (the same as for the SCM IOPs) over the duration of the IOP, scheduled for September 22 through October 20, 1995.

Although more instrumentation will be added, the SGP site central facility and boundary facilities are nearly complete, and routine operations have been established for most platforms. The emphasis in this six-month period will be on completing the installation of the remaining extended facilities and implementing one auxiliary and three intermediate facilities.

Although budgetary limitations have somewhat slowed the development and completion of the site, eight permanent extended facilities are in place. An ambitious schedule for finishing the installation of 17 of the remaining 19 extended facilities is in place. Activities to develop boundary facilities will be limited to establishing permanency (i.e., installation of T-1 lines [dedicated, high-speed, serial data transmission lines] and support trailers) and will result in the completion of those facilities. At the central facility, the aerosol and calibration facilities will be outfitted with support structures, instruments will be installed, and site operators will be trained during this six-month period. Establishment of one auxiliary facility will be needed to accommodate the installation of a second day-night whole-sky imager (WSI). The IDP instruments expected to be accepted as CART instruments during this period are the day-night WSI, the Raman lidar, two atmospherically emitted radiance interferometers (AERI 01 and AERI X), a solar radiance transmission interferometer (SORTI 01), and the micropulse lidar (MPL). In addition, the Belfort laser ceilometer (BLC) was recently accepted (June 1995) as a CART instrument. The IDP millimeter cloud radar is not expected to become a CART instrument during this period.

All current (and future) solar and infrared radiation observing systems (SIROSs) have been upgraded with SciTec solar tracking and shading assemblies. These will improve measurements of the direct and diffuse broadband solar radiation and diffuse hemispheric broadband infrared radiation, which are important elements in the IRF measurements. Deployment of SIROSs at the remaining extended facilities is dependent on the availability of broadband radiometers. As in the case of SIROSs, installation of eddy correlation (ECOR) instruments is dependent on availability from the vendor. However, the physical infrastructure at all extended facilities will be completed during this period, probably before instrument deployment.

During this six-month period, we will address additional SCM, DA, and HD boundary layer measurement needs with the procurement of three 915-MHz profilers with radio acoustic sounding systems (RASSs). These instruments will be deployed at locations between the central and boundary facilities to enhance the boundary layer monitoring across the total SGP CART site. This deployment will require additional leasing of property and environmental assessments at the new locations, which will be referred to as "intermediate facilities."

A unique opportunity to supplement the existing CART instrumentation was proposed by the SST and has been funded by the GEWEX Continental-Scale International Project (GCIP). This support will permit additional sensors for profiling of soil moisture and temperature to be installed at the central facility and extended facilities during this period, with the network being completed by the spring of 1997. These additional sensors will support water and energy budget analyses, diagnostic studies, and model validation efforts of ARM and GCIP investigators. Installation is planned to begin in September of 1995 and to continue through the remainder of this six-month period.

Site operations will continue to support activities necessary for the IDP during IOPs. For example, operation of the Ground-Based Remote Sensing (GBRS) IOP was supported at the SGP CART site during the spring 1995 SCM IOP. The IDP instruments evaluated during this exercise included the CART AERI 01 and CART AERI X, the Raman lidar, the University of Massachusetts cloud profiling radar system, and the CSIRO (Commonwealth Scientific and Industrial Research Organization) infrared radiometer. The resulting data should be available by the end of this six-month period. The GBRS IOP marked the last formal IOP dedicated to the IDP, which is in its final year. The remaining IDP-related efforts will be dedicated to configuring systems for permanent deployment at the CART sites and evaluating a few remaining instruments in need of field verification. These activities will occur during the next six months.

In summary, our goals for this six-month period are to provide the Science Team with a suite of measurements that will support a wide range of research, to establish solid procedures for instrument calibration and maintenance, and to continue the series of QMEs. Quality assurance efforts are central to the success of the entire program.

3 ROUTINE SITE OPERATIONS

3.1 Overview

The overwhelming majority of the measurements with the highest priority, on which the existing experimental designs are based, are regular (i.e., routine) observations, as specified in the *ARM Program Plan, 1990* (U.S. Department of Energy 1990). Scientifically and logistically, routine operations will also serve as the basis and background for all nonroutine operations, including instrument development activities, IOPs, and collaborative campaigns directed toward obtaining difficult-to-gather or expensive *in situ* data. Consequently, development and validation of the basic observations remain a top priority. Site development has progressed sufficiently to support three IOPs addressing key scientific questions during this six-month period. In addition, the IOPs are an opportunity to provide more focused data sets to the Science Team and the scientific community at large.

The SST will work to ensure the scientific productivity of the site by providing guidance to the site operations manager and his staff on scientific matters related to the data stream, by answering questions from operations personnel concerning potential instrument problems, by reviewing schedules and procedures for instrument maintenance and calibrations, by reviewing designs for infrastructure supporting new instruments, by contributing to the design of the standard operating procedures, by reviewing and developing plans for special operations, and by helping to establish forecast support for routine and special operations. The SST, in cooperation with instrument mentors, will generally oversee the quality control effort at the CART site, a continuous activity that includes daily monitoring of the CART data streams in collaboration with the staff at the central facility and the development of a quality assurance plan that will address the data originating at the SGP site.

By the end of this period, the SGP CART site will be nearly complete except for an operational Raman lidar, a millimeter cloud radar, the CART SORTI and AERI X, three intermediate-facility 915-MHz profilers and RASSs, and four extended facilities. Routine operations are considered to be the activities related to the operating and maintenance of instruments, the gathering and delivery of the resulting data, and the planning for scientific investigations, including IOPs, campaigns, and QMEs. The site cannot be operated routinely in a formal sense until all planned instrumentation is in place. The process that leads to implementation of CART instruments is the Pre-Readiness Review (PRR). The PRR includes the identification of requirements for instrument design and installation and the development of the documentation, procedures, and training needed to maintain CART instrumentation and integrate data streams into the site data system. The PRR also provides a forecast of when these instruments will be fully operational and delivering data to the Experiment Center and the Archive.

The expectation for routine operation of instruments is that they will require servicing by site operators only once every two weeks. If an instrument failed during a two-week period at an extended facility, data streams could be lost, by design. Such a loss of data is acceptable to the ARM Program. The data collected at all extended and boundary facilities by the end of this period are expected to be polled frequently each day by the site data system at the central facility, then packaged and delivered to the Experiment Center and the Archive once daily. The Experiment Center generally delivers data to Science Team members and other data requesters once weekly.

Site operations proposed an instrument triage plan during the spring of 1995 for IOPs and campaigns. The plan calls for identifying instruments, individual sensors, and communication links in need of more frequent servicing than the routine operation requirements mentioned above. The priority of triage efforts will be determined by the site scientist, who will take into consideration the importance of a particular data stream to the success of the scientific investigation(s). The evaluation and formal implementation of the triage plan will be an ongoing effort during the upcoming six months. Part of the evaluation will be budgetary impact.

Handling of instruments that must be returned to the vendor for calibration and servicing is also part of routine operation. Replacement instruments and sensors will be rotated regularly to meet these requirements. A comprehensive, integrated calibration plan will be generated by the site scientist in conjunction with the site operations manager during the next six months. Changeouts of all sensors and instrumentation are recorded in the site operations log.

The initial checks on data quality after instrument installation are provided by the instrument mentors. After the mentor reviews the data stream to ensure that the acquired instrument is performing properly and that the data are identified accurately by the Experiment Center, the mentor approves a "beta" release. The beta release provides data to selected Science Team members who have requested them and are willing to work with the instrument mentor on data quality issues. Beta releases are established after the instrument mentor and an appropriate member of the DSIT create a general statement on data quality for the Experiment Center. Beta releases are also available to other Science Team members who are willing to work in conjunction with the instrument mentor. When the data quality is consistently acceptable and well documented, the mentor approves a "full" release of the data.

3.2 Routine Operations

3.2.1 Functional Instruments and Observational Systems

Accomplishments in the area of site development are most evident at the central facility, with its functioning power and fiber-optic infrastructure and an array of instruments. Thirteen extended facilities (including a subset of instrumentation equivalent to that at the central facility) have at least a partial suite of instruments in place, and eight are fully instrumented now that their SIROSs are installed. Four boundary facilities are also in operation. Data are currently transferred from the boundary facilities by overnight express service to the central facility for data ingestion; however, T-1 lines are planned for installation at all boundary facilities during the upcoming six-month period. Figure 1 is a map of the SGP site showing the locations of the developed extended and boundary facilities. The status of the systems and instruments on June 30, 1995, is summarized in Tables 1 and 2.

3.2.2 Launch Schedule for BBSSs

Until the full suite of remote-sensing systems is deployed to perform deep, detailed soundings of the wind, temperature, and moisture of the troposphere under a wide range of conditions, the BBSS will continue to be an expensive workhorse because of the cost of the expendables and manpower associated with an ambitious schedule of radiosonde launches. The number of BBSS launches sitewide should eventually be reduced to a minimum needed to support routine cross-checks on the remotely sensed measurements, but we are a number of years from that goal. The frequency of routine launches at the central facility during this six-month period will be the same as in the previous six months. Routine operations (see Table 3) will include five daily launches at the central facility and one daily launch at each of the four boundary facilities.

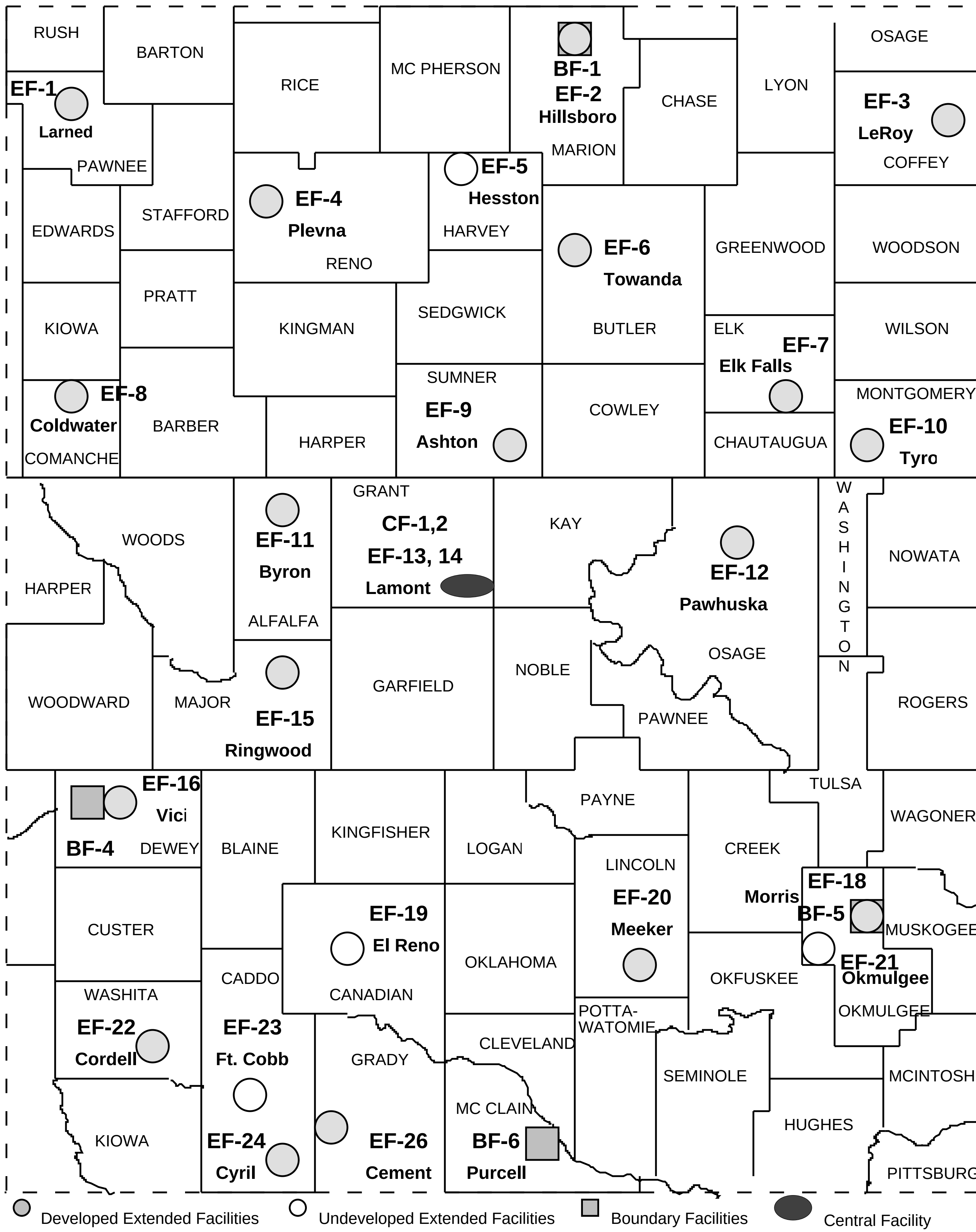

FIGURE 1 Overall View of the SGP CART Site (Scale: 50 km/in.)

TABLE 1 Locations and Status of Extended Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SMOS[c]	SIROS[c]	Comments
Larned, KS EF-1	632	38.202 N 99.316 W	Wheat	ECOR 9/95	Yes 9/95	Yes 9/95	Power and communication center installation planned for July 1995
Hillsboro, KS EF-2	450	38.306 N 97.301 W	Pasture	EBBR 8/95	No	Yes 8/95	Power and communication center installation planned for July 1995
LeRoy, KS EF-3	338	38.201 N 95.597 W	Wheat and soybeans (rotated)	ECOR 10/95	Yes 10/95	Yes 10/95	Power and communication center installation planned for September 1995
Plevna, KS EF-4	513	37.953 N 98.329 W	Rangeland (ungrazed)	EBBR 4/4/93	Yes 3/28/95	Yes 3/28/95	Power and communication center installed March 1995
Hesston, KS EF-5	—	No location identified	—	—	—	—	Lease canceled in 1995; no new location identified at this time
Towanda, KS EF-6	409	37.842 N 97.020 W	Alfalfa	ECOR 9/95	Yes 9/95	Yes 9/95	Power and communication center installation planned for August 1995
Elk Falls, KS EF-7	283	37.383 N 96.180 W	Pasture	EBBR 9/8/93	Yes 3/9/95	Yes 3/9/95	Power and communication center installed February 1995

TABLE 1 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SMOS[c]	SIROS[c]	Comments
Coldwater, KS EF-8	664	37.333 N 99.309 W	Rangeland (grazed)	EBBR 12/8/92	Yes 3/4/93	Yes 5/9/95	Power and communication center installed May 1995
Ashton, KS EF-9	386	37.133 N 97.266 W	Pasture	EBBR 12/10/92	Yes 3/13/90	Yes 10/5/93	Power and communication center installed October 1993
Tyro, KS EF-10	248	37.068 N 95.788 W	Wheat	ECOR 7/95	Yes 7/95	Yes 7/95	Power and communication center installation planned for June 1995
Byron, OK EF-11	360	36.881 N 98.285 W	Alfalfa	ECOR 6/26/95	Yes 6/26/95	Yes 6/26/95	Power and communication center installation planned for June 1995
Pawhuska, OK EF-12	331	36.841 N 96.427 W	Native prairie	EBBR 9/11/93	None	Yes 6/30/95	Power and communication center installation planned for June 1995
Lamont, OK EF-13, 14	318	36.605 N 97.485 W	Pasture, wheat	EBBR 8/24/92 ECOR 5/30/95	Yes 4/9/93	Yes 10/15/93 BSRN 5/15/92	Power and communication center installed June 1993
Ringwood, OK EF-15	418	36.431 N 98.284 W	Pasture	EBBR 9/25/92	Yes 3/29/93	Yes 10/12/93	Power and communication center installed October 1993

TABLE 1 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SMOS[c]	SIROS[c]	Comments
Vici, OK EF-16	602	36.061 N 99.134 W	Wheat	ECOR 5/30/95	No	Yes 5/30/95	Power and communication center installed May 1995
EF-17	—	Un-specified	—	—	—	—	—
Morris, OK EF-18	217	35.687 N 97.856 W	Pasture (ungrazed)	EBBR 10/95	No	Yes 10/95	Power and communication center installation planned for September 1995
El Reno, OK EF-19	—	No location identified	—	—	—	—	Lease canceled 1995; no new location identified at this time
Meeker, OK EF-20	309	35.564 N 96.988 W	Pasture	EBBR 4/3/93	Yes 4/2/93	Yes	Power and communication center installed October 1994
Okmulgee, OK EF-21	—	No location identified	Forest	ECOR	Yes	Yes	No lease agreement; power and communication center installation unknown at this time
Cordell, OK EF-22	465	35.354 N 98.977 W	Rangeland (grazed)	EBBR 4/4/93	No	Yes 4/26/95	Power and communication center installed March 1995

TABLE 1 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SMOS[c]	SIROS[c]	Comments
Ft. Cobb, OK EF-23	415	35.153 N 98.461 W	Peanuts (irrigated)	ECOR 10/95	No	Yes 10/95	Power and communication center installation planned for October 1995
Cyril, OK EF-24	409	34.883 N 98.205 W	Wheat (gypsum hill)	ECOR 8/95	Yes 8/95	Yes 8/95	Power and communication center installation planned for June 1995
EF-25	—	Un-specified	—	—	—	—	—
Cement, OK EF-26	400	34.957 N 98.076 W	Pasture	EBBR 9/20/92	No	No	Phone line (only) installed October 1992

[a] BSRN, Broadband Solar Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation.

[b] Above sea level.

[c] Date indicates actual or scheduled installation date.

TABLE 2 Instruments and Observational Systems in Place at the Central, Boundary, Extended, and Auxiliary Facilities on June 30, 1995[a]

Central Facility

Radiometric Observations

- AERI
- SORTI (limited operations in test mode)
- ARM BSRN
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
- SIROS
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
  - Pyranometer (upwelling, above pasture at 10 m)
  - Pyrgeometer (upwelling, above pasture at 10 m)
- MFR (upwelling, above pasture at 10 m)
- Pyranometer (upwelling, above wheat at 25 m on 60-m tower)
- Pyrgeometer (upwelling, above wheat at 25 m on 60-m tower)
- MFR (upwelling, above wheat at 25 m on 60-m tower)
- EBBR
- ECOR
- SMOS

Wind, Temperature, and Humidity Sounding Systems

- BBSS
- 915-MHz profiler with RASS
- 50-MHz profiler with RASS
- MWR
- Heimann IR thermometer

Cloud Observations

- WSI
- BLC (interim)
- MPL (IDP) ceilometer

Others

- Temperature and humidity probes at 60 m on tower

Extended Facility Components

- SIROS
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
  - Pyranometer (upwelling, at 10 m)
  - Pyrgeometer (upwelling, at 10 m)

TABLE 2 (Cont.)

Extended Facility Components (Cont.)

EBBR
SMOS

Auxiliary Facilities

None in preparation

Boundary Facilities

BBSS
MWR

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; ARM BSRN, ARM Program Broadband Solar Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IOP, Intensive Observation Period; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; RASS, radio acoustic sounding system; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; WSI, whole-sky imager.

TABLE 3 Radiosonde Launch Schedule for July 1-December 31, 1995 (Times in UTC)[a]

Central Facility	Boundary Facilities
Routine Operations, July 1-16, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	
SCM IOP, July 17-August 6, Monday-Sunday	
0300	0300
0600	0600
0900	0900
1200	1200
1500	1500
1800	1800
2100	2100
2400	2400
Routine Operations, August 7-September 21, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	
ARESE/SCM IOP, September 22-October 20, Monday-Sunday	
0300	0300
0600	0600
0900	0900
1200	1200
1500	1500
1800	1800
2100	2100
2400	2400

TABLE 3 (Cont.)[a]

Central Facility	Boundary Facilities
Routine Operations, October 21-December 31, Monday-Sunday	
0600	
1200	
1500	1800
1800	
2100	

[a] UTC, universal time coordinated. Launch time is 30 min earlier; the stated time represents the approximate midpoint of the flight.

The current routine launch times at the central facility were chosen to facilitate IRF and IDP research, and the launch times at the boundary facilities were chosen to support the MWR and the nearby National Oceanic and Atmospheric Administration (NOAA) 404-MHz profilers with further RASS deployment and to complement the wider network of National Weather Service (NWS) launches. Remote sensing of virtual temperature profiles at all boundary facilities is provided by the nearby NOAA profilers, which are being outfitted with ARM-provided RASS units. A RASS unit has been installed at Purcell, and installation of the unit at Vici is planned for this six-month period. The schedule for the installation of RASSs at Hillsboro and Morris is unknown at this time.

The four boundary facilities routinely launch radiosondes once daily at 1800 Greenwich mean time or noon local time. Boundary facilities will be staffed only during the period of 1030-1430 local time, Monday through Friday (including holidays). During IOPs, the boundary facilities will be staffed 24 hours per day for 21 consecutive days (including holidays) to facilitate releases every 3 hours (Table 3).

The central facility will be staffed from 0530 to 2100 and from 2330 to 0330 local time, Monday through Friday (including holidays). During IOPs, the central facility will be staffed 24 hours per day, 7 days per week (including holidays) to facilitate round-the-clock releases every 3 hours.

3.3 Instruments

A CART instrument is any instrument for which the site operations management has accepted responsibility for operation and maintenance. The Pre-Readiness Review (PRR) and Operational Readiness Review (ORR) forms are requests for information that facilitates the installation and operation of instruments or facilities at the SGP CART site. The purpose of these reviews is to achieve an efficient handoff of instruments and facilities from instrument mentors to site operators. Figure 2, the SGP CART instrumentation implementation flow chart, contains information obtained from the PRR and ORR documentation. When all procedures, operations manuals, and training pertaining to an instrument have been completed, the instrument is accepted by the site operations management. If sufficient documentation is available to operate an instrument, even though more will ultimately be required for full acceptance, the instrument may be operated in a degraded mode. The status of the instruments is summarized in Table 4.

The AERI 01, which has an upgraded design using electronic cooling, was installed at the SGP CART site during the spring 1995 GBRS IOP. The former IDP AERI 00 system required liquid-nitrogen cooling, which necessitated additional maintenance by site operators; during past SCM IOPs, site operators hand-filled the AERI 00 with liquid nitrogen at the beginning of each of three shifts.

The SORTI 00 will be phased out with the introduction of the SORTI 02 in June 1995. The Spinhirne MPL (on loan from the National Aeronautics and Space Administration [NASA]) has been operating intermittently in the optical trailer and is to be replaced by the CART MPL, scheduled for installation in late July 1995. The BLC, which is operating about 3 m east of the optical trailer, has proven to be relatively robust. The WSI instrument, on temporary loan, is located about 15 m south of the optical trailer, at a location high enough so that the optical trailer does not interfere with the field of view. The CART WSI is planned for installation in late July 1995.

The radiometer calibration facility (RCF) is scheduled for installation at the site, to begin during October 1995 and to be completed by the end of November 1995. The contract for the facility will be awarded in July, after completion of the vendor review process. Procedures are being developed to establish the number of sensors required, the required frequency of calibration for all radiometers at the SGP site, the frequency of sensor changeouts, and a method for tracking all sensors. Full operation of the RCF is anticipated in December 1995.

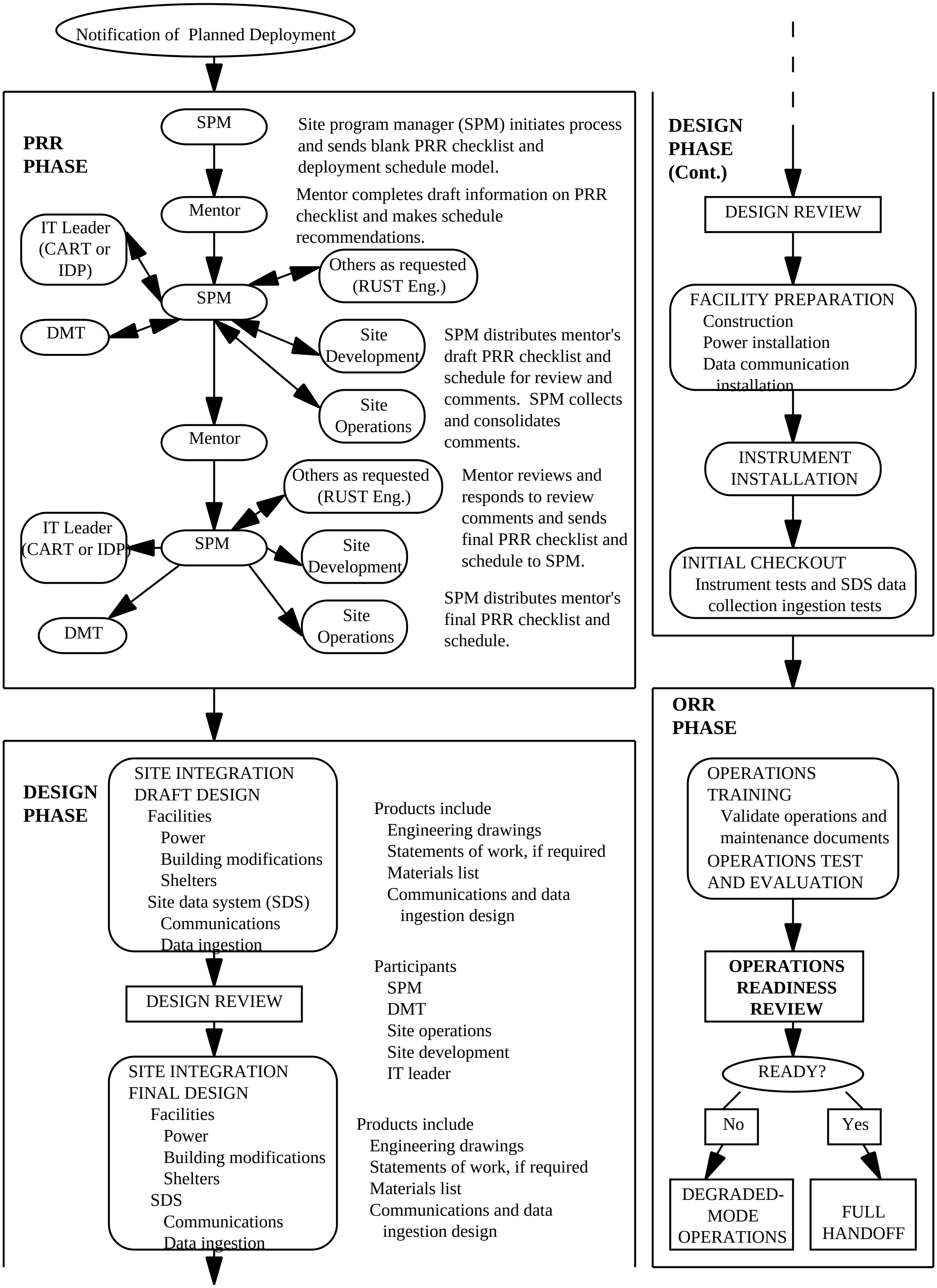

FIGURE 2 SGP CART Instrumentation Implementation Flow Chart

TABLE 4 Status of SGP CART Instrumentation on June 30, 1995[a]

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
BBSS PC Cora	CART	3/15/92	1/27/93	Yes	—
MWR	CART	11/2/92	5/17/95	Yes	—
EBBR	CART	11/24/92	11/24/92	Yes	—
SORTI 00	IDP	1/15/93	1/15/93	No	Yes
915-MHz Profiler and RASS	CART	1/30/93	1/30/93	Yes	—
BLC	CART	3/15/93	5/19/95	Yes	—
BBSS Digi-Cora	CART	3/15/93	4/15/93	Yes	—
AERI 00	IDP prototype	3/18/93	3/18/93	No	Yes
SMOS	CART	6/10/93	6/10/93	Yes	—
SIROS	CART	9/15/93	5/17/95	Yes	—
MPL 00	IDP prototype	9/15/93	5/22/95	No	Yes
25-m Upwelling IR/S radiometer	CART	9/15/93	5/22/95	Yes	—
25-m MFR	CART	9/15/93	5/22/95	Yes	—
10-m MFR	CART	9/15/93	5/22/95	Yes	—
WSI 00	IDP loaner	10/18/93	5/22/95	No	Yes
50-MHz Profiler with RASS	CART	1/30/94	1/30/94	Yes	—
C3 (mobile system) ECOR	CART	3/15/95	—	—	—

TABLE 4 (Cont.)

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
AERI 01	CART	4/22/95	5/17/95	No	No
C2 (3-m tower) ECOR	CART	5/16/95	5/18/95	No	Yes
MPL 02	CART	8/95	—	—	—
WSI 01	CART	8/95	—	—	—
C1 (60-m tower) ECOR	CART	8/95	—	—	—
Aerosol facility	CART	8/95	—	—	—
Raman lidar	IDP/CART	9/15/95	—	—	—
RCF	CART	11/95	—	—	—
SORTI 01	CART	1/96	—	—	—
Millimeter cloud radar	IDP/CART	2/96	—	—	—

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; CART, Cloud and Radiation Testbed; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MPL, micropulse lidar; MWR, microwave radiometer; ORR, Operational Readiness Review; PC, personal computer; RASS, radio acoustic sounding system; RCF, radiometer calibration facility; S, solar; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; WSI, whole-sky imager.

Completion of the construction of the aerosol trailer in August or September 1995 will set the stage for the facility to become fully operational by November 1995. Equipment intended for installation includes an optical particle counter (0.1-10 µm); an integrating nephelometer for three wavelengths (450, 500, 700 nm); an integrating nephelometer with a 550-nm reference; a condensation particle counter (total > 0.1 µm); an ozone concentration sensor; and (perhaps) an optical absorption unit.

One additional extended facility (near Cement in Grady County, Oklahoma) has already been made a permanent facility. This facility supports the Global Energy and Water Cycle

Experiment (GEWEX) Continental-Scale International Project (GCIP), the GEWEX Cloud System Study (GCSS); the U.S. Department of Agriculture-Agriculture Research Service (USDA-ARS) Global Change, Water Resources, and Agriculture program; and NASA studies in the Little Washita watershed. All but two extended facilities will be augmented with SIROS systems by the end of this six-month period. The presently uncompleted extended facilities will require some or all of the following: installation of power and communications, construction of power and signal infrastructures, installation of automatic switches so that the site data system (SDS) can interrogate extended facilities for data, and acquisition of suitably sized uninterruptible power supplies. In addition, the extended facilities will be equipped with the full complement of vendor-available instrumentation to monitor the surface radiation and heat budgets and associated parameters (surface meteorological observation system [SMOS], SIROS, and energy balance Bowen ratio [EBBR] or ECOR systems).

The current status of and plans for acquisition and deployment of instruments are summarized in Tables A.1-A.3 in Appendix A. During this six-month period, the central facility should gain a photosynthetically active radiometer (PAR) and an ultraviolet B (UV-B) radiometer, as well as the radiometers associated with the RCF. Because of budget limitations, spectral analysis will not take place at the central facility, but it remains an upgrade option for later. Also anticipated is the suite of instrumentation associated with the aerosol trailer.

Ozone sondes were originally included in the list of instruments planned for the SGP site, in anticipation of a need to correct measurements of radiative flux divergence on the basis of vertical ozone profiles. However, recent analysis of SPECTRE data indicated that the error in flux divergence (with and without ozone profiles) was less than 2%, a figure smaller than the inherent model errors. The need for ozone profiles is being examined continuously. The installation cost is moderate ($20,000), but the individual ozone sondes are expensive ($700 per sonde), and manpower needs are intensive. A potential need for ozone profiles concerns the overlap of the ozone and water vapor absorption bands in the region of the AERI data around a wave number of 1150. This overlap may require ozone profiles for analysis. In addition, requirements for the ARESE IOP include daily ozone launches during a four-week period. The current plans are to subcontract daily ozone sondes for the ARESE IOP. The ARESE ozone sonde data will subsequently be used to evaluate the need for routine ozone profiles.

3.4 Observations, Measurements, and External Data

The observations being delivered to the Experiment Center from the SGP CART site as of June 30, 1995, are summarized in Table B.1 in Appendix B. The availability of data from a particular platform on any given day is a function of quality control, with some segments temporarily unavailable during evaluation or correction of problems. Instruments operating at the site that are not in Table B.1 either are still under evaluation by the instrument mentors or are awaiting the creation of the data ingestion modules required to add their data to the SGP data stream.

The measurements being produced at the Experiment Center as of June 30, 1995, for distribution to the Science Team are listed in Table B.2 in Appendix B. This summary includes both the measurements derived from the SGP CART data and data streams from sources external to ARM (e.g., the gridded data from the National Meteorological Center's ETA Model). Table B.3 in Appendix B lists the external data that currently supplement the SGP CART data.

The Experiment Center will continue to prepare software to produce measurements from the available observations. The status of the observations near the beginning of this six-month period (July 1, 1995) is summarized in Table B.4 in Appendix B. Table B.5 in Appendix B provides a list of measurements, organized by type, derived from the SGP CART site and external data that are anticipated to exist by the end of this period (December 31, 1995).

3.5 Site Development Activities

3.5.1 Facilities

Most of the infrastructure at the central facility is complete, including the power, telephones, and fiber-optic data network, along with three IDP pads that have continued to support visiting instruments. In anticipation of the arrival of two daytime-nighttime WSIs, the first of a planned six auxiliary facilities will need to be located. Auxiliary facilities are to be 5-10 km distant from the central facility and at approximately the same elevation as the central facility. At least one auxiliary facility is expected to be located and leased during this period.

To accommodate the T-1 lines planned at the boundary facilities, a new trailer (10 × 30 ft) is being procured for installation sometime in December. The new trailer, a new SDS changeout, and increased work space to accommodate delivery of a future AERI and potentially other equipment will finalize the boundary facilities. The final installation of the BBSS trailer on a concrete pad with a zero-plane grounding system will further reduce potential interference from the nearby NOAA profilers. This work is all expected to be completed during the current six-month period.

New locations for the three intermediate facilities with the new 915-MHz profilers and RASS units will be selected during the next six months. On the basis of a recommendation from a subset of the Science Team, general locations will be identified. Three potential sites for each of these intermediate facilities will be found and submitted to the respective states, Kansas and Oklahoma, for National Environmental Policy Act (NEPA) approval and leasing. Subsequently, support infrastructure (utilities, cement pads, housing structures for computers, etc.) can be implemented, and the instruments can be installed by the vendors. Selection of and obtaining approvals for intermediate facilities and implementation of the infrastructure are planned for this period, but instrument delivery schedules are uncertain.

As new IDP and CART instruments arrive at the central facility, special support structures will be required. For example, the optical trailer was modified to accept the CART AERI 01. The new WSI will require a taller platform to raise the instrument above planned modifications to the optical trailer roof line resulting from requirements of the SORTI solar tracker. The pad for the Raman lidar will be constructed at IDP location 3. These activities are planned for this six-month period.

Figure 3 summarizes site development activities during the next six months. Milestones and complex tasks are distinguished from simple tasks or activities.

3.5.2 Development of the Site Data System

Several of the installed instruments and all of the new instruments will require creation of software to transfer the data from the instrument platforms to the SDS. Transfer of data by coded switches from the extended facilities has been established. Because the telephone lines cannot support data transfer from the boundary facilities, T-1 lines will be installed at these locations. Currently, the data from the boundary facilities (on cartridge tape) are delivered to the central facility daily by overnight express mail. This system causes a delay of 3-5 days in data ingestion in the SDS. The majority of the ARM SGP instruments have their data collected (or delivered) to the SDS regularly with data processed (i.e., ingested) and passed on to the Experiment Center

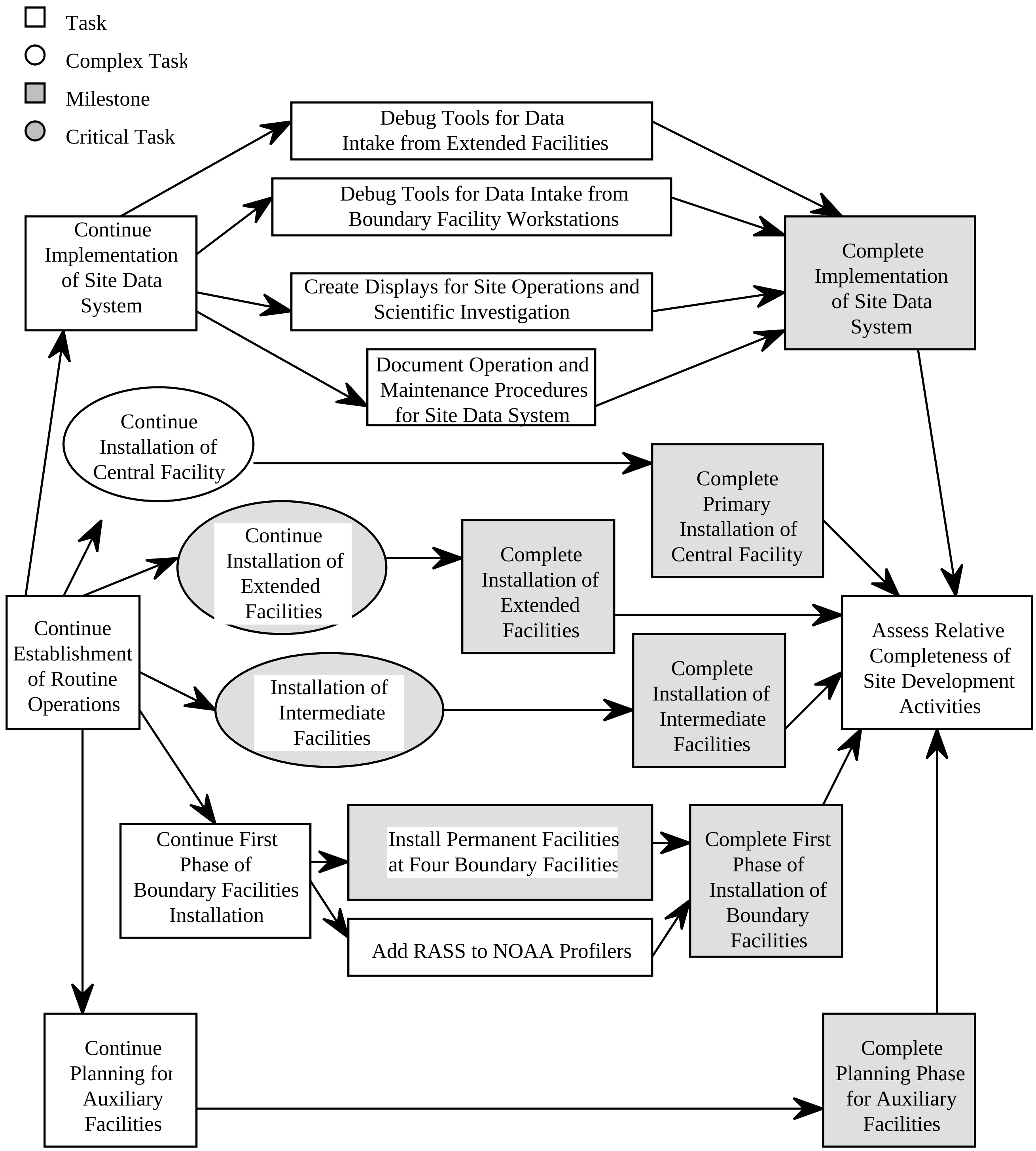

FIGURE 3 Site Development Activities to Establish Routine Operations during July-September 1995

and the ARM Archive. Some exceptions to this pattern will continue to occur during the next six months. These exceptions are as follows:

- SORTI. The SORTI data are retrieved directly by the instrument mentor and do not enter the SDS computers.

- WSI. The WSI is not connected to the network. The data are written directly to tape, and the tapes are shipped to the instrument mentor.

- AERI 01. The AERI 01 data are retrieved by the Experiment Center, and ingestion of the data is performed there. The data do not enter the SDS computers.

- MPL. The MPL data are received by the SDS computers but are not processed (because no ingestion module has been developed yet), except that the raw data files are renamed to the ARM file-naming standard.

- BLC. The BLC data are collected by the SDS computers, but the processing (ingesting) of the data currently takes place at the Experiment Center.

- ECOR. The 3-m ECOR systems recently installed at the central facility and extended facilities currently write data files to an optical drive unit that stores data for 12 days. After this time, the data are written over the last existing data files, and so the last 2 days will be lost until the communications module is completed. The instruments were installed earlier than planned, ahead of the SDS schedule, to support the Surface Energy Exchange IOP from June 26 to July 14. The optical data tapes will be sent to the instrument mentor for data processing until the SDS communication file is complete. Data will be retrieved only every 2 weeks from extended facilities.

Further work is needed to facilitate routine operations, particularly to assess instrument performance, including a broader suite of data display capabilities. Once the SDS is near completion, procedures for system management and maintenance need to be written and transferred to site operations. In addition, the SDS will address the ongoing need to make near-real-time data available for selected scientists during IOPs and campaigns and for educational outreach efforts in conjunction with the Oklahoma Climate Survey's EARTHSTORM project.

3.6 Limiting Factors

The most basic of limiting factors is the amount of resources available for continuing site development, expanding operations, and providing necessary support for the IT, DMT, and DSIT. Shortfalls result in delays in implementation. Shortfalls in vendor supplies, delays in obtaining information for PRRs, and budgeting problems have also been hindrances. Other significant limiting factors are the time lags inherent in the procurement process and the calibration of radiometers before installation.

All systems awaiting construction or installation go through a formal design review of structural and mechanical systems; for example, the aerosol intake stack for the aerosol trailer, the structure housing the CART Raman lidar, and the RCF have undergone such review. These reviews frequently identify deficiencies in plans and drawings related to engineering requirements, procurement details, safety, and quality control. This review activity was recently expanded to include large or complex IOPs (e.g., the Cloud Remote Sensing IOP in April 1994, the GBRS IOP in April 1995, and the upcoming ARESE IOP in September 1995) in an effort to integrate the exceptionally wide variety of IDP instrument support requirements for cost-effective and safe implementation. Neither construction nor installation can begin until the design review process has been successfully completed.

The costs associated with BBSS launches (primarily expendables) will continue to be a burden on the operations budget until these systems are replaced by continuous, unmanned remote-sensing systems. These expenses are a strong constraint on the total number and frequency of launches, making impossible the routine provision of all of the requested launches (eight per day at the central and boundary facilities) defined as the optimal sounding strategy for SCM requirements by the DSIT (M. Bradley and R. Cederwall, unpublished information).

4 SCIENTIFIC INVESTIGATIONS AND OPPORTUNITIES

The ARM Program has identified a need for the SAC to provide assistance to the ARM Program Science Team, the SGP CART site scientist, and the SGP CART site program manager. The SAC's charter is to

- Evaluate the SGP CART site scientific mission,
- Provide scientific mission guidance for SGP CART site operations,
- Evaluate the research program of the site scientist,
- Evaluate the potential for collaboration with other research programs, and
- Provide recommendations for the SGP CART site educational outreach program.

The seven-member SAC will be composed of ARM and non-ARM Program scientists who will meet formally at least once per year. A written report summarizing the committee's recommendations will be prepared for distribution to the ARM Science Team after each meeting. Committee membership will be for three years.

4.1 Intensive Observation Periods

The base of the ARM Program at the SGP CART site is a suite of continuous observations, but a number of critical observations are either too expensive to be produced continuously or require instrumentation that cannot be deployed continuously. In addition, some questions concerning data accuracy or representativeness (for either established instruments or prototypes) can be answered only with periods of more frequent observations. Acquiring these observations will require special efforts and arrangements by the SGP site staff; such events are categorized as IOPs, because they frequently include activities beyond the routine observations. The IOPs can be in support of the needs of the Science Team, QMEs, IDPs, campaigns, and even field tests of non-ARM instruments. Table 5 lists IOPs that have occurred, are occurring, or are in the design stage.

TABLE 5 Intensive Observation Periods

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
11/92	Field Test of NCAR Flux Profiler	D. Parsons (NCAR)	R. Cederwall	Enhanced soundings at the central facility and profiler site were made 11/10-11/19; boundary layer flights were also conducted on a few days.	Completed; data available summer 1993
4/93	AERI Field Test	H. Revercomb (UW)	J. Liljegren	Enhanced soundings at the central facility were requested during the field acceptance test of the AERI instrument.	Completed 4/29/93
5/93-6/93	Using the GPS for the Measurement of Atmospheric Water Vapor	Collaborative (UNAVCO and NCSU)	J. Liljegren	The purpose was to test the investigators' technique for inferring total precipitable water vapor in the atmosphere column by using GPS signals.	Completed 6/8/93; data available
6/93	Warm-Season Data Assimilation and ISS Test	D. Parsons (NCAR)	R. Cederwall	This test was an enhanced sampling (in time and space) of the SGP domain for a 10-d period with profilers and sondes. The primary goals of the IOP were (1) to study the performance of FDDA under thermodynamic conditions typical of the continental warm season and (2) to evaluate the estimates of divergence and vorticity from the prototype NCAR ISS with interferometric techniques, the triangle of three 915-MHz profilers, and the results of FDDA.	Completed; all data available at the Experiment Center except for FDDA, which is available upon request at NCAR
5/94	VORTEX IOP	E. Rasmussen (NSSL)	T. Cress	Special launches were made in support of VORTEX, testing hypotheses on the development and dissipation of severe storms.	IOP completed May 31, 1994; data availability yet to be determined
8/94	GEWEX/GCIP/ GIST IOP	Collaborative	T. Cress	Special launches were made in support of the GCIP and GIST as part of an effort to improve climate models by improving parameterizations of hydrologic and energy cycles.	IOP successfully conducted in August 1994

TABLE 5 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
2/95	MSX Satellite Overflights	Collaborative	T. Cress	The purpose is to provide ground truth support for the MSX satellite. Nine sensors operate in the range of 0.12-0.9 µm. A spectral IR imaging telescope also operates.	Postponed
2/95; 5/95	Atmospheric Emission Sounder Overflights	S. Clough (Atmospheric and Environmental Research, Inc.)	M. Laufers-weiler	Special ozone sonde launches supported these flights.	Planning underway
3/95-4/95	Surface Flux Responses to Frontal Passages	W. Blumen (University of Colorado); L. Mahrt (Oregon State University)	R. Cederwall	Documented the changes in surface layer fluxes in response to frontal passages.	Under discussion
1/94; 4/94; 7/94; 10/94; 4/95	Seasonal SCM IOP	D. Randall (CSU)	M. Leach	Seasonal IOP with enhanced frequency of observations, particularly vertical soundings of temperature, water vapor, and winds at central facility and boundary facilities for periods of 21 d; the required sounding frequency is 8/d. The data are required for quantifying boundary forcing and column response.	IOPs being planned for July 1995 and September 1995

TABLE 5 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
4/95-5/95	Simultaneous Ground-Based, Airborne, and Satellite-Borne Microwave Radiometric and *In Situ* Observations of Cloud Optical Properties and Surface Emissivities	W. Wiscombe (NASA-GSFC); E. Westwater (NOAA-ETL)	M. Laufers-weiler	Observations of cloud optical properties obtained over the CART site simultaneously from ground-based, *in situ*, and satellite-borne sensors; spatial variability of surface emissivities assessed to attempt retrieval of total precipitable water and cloud liquid water from the special sensor microwave imager.	Proposal distributed (to IRF group contact); initial planning discussions between Wiscombe and L. Fedor at NOAA; proposal for 45 h of NOAA P-3 flight time awarded to Wiscombe and Schneider in collaboration with VORTEX
4/94-5/94; 4/95-5/95	Remote Cloud Sensing Field Evaluation	R. McIntosh (UM); B. Kropfli (NOAA); T. Ackerman (PSU); K. Sassen (UU); A. Heymsfield (NCAR); and others	M. Laufers-weiler; J. Griffin (IDP contact)	The primary purpose is the field evaluation and calibration of several remote-sensing cloud-observing instruments (some of which are from the IDP project). *In situ* cloud observations are critical to the success of this IOP. Enhanced soundings are required at the central facility.	IOP completed May 1, 1994; data availability in progress and summary report in preparation; data availability of 1995 effort currently unknown
4/95-5/95	VORTEX-ARM	E. Westwater (NOAA-WPL); W. Wiscombe (NASA-GSFC); G. Stephens and P. Gabriel (CSU); J. Schneider (CIMMS/NSSL)	T. Cress	Joint VORTEX/ARM proposal approved for 45 h of P-3 aircraft time to study stratocumulus clouds. Coordination with Remote Cloud Sensing IOP is being discussed.	Under discussion

TABLE 5 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
5/94; 1995 dates to be deter-mined	WB-57 Overflight for the Measurement of Atmospheric Water Vapor at High Altitude	Collaborative (Visidyne and Lockheed PARC)	J. Liljegren	The purpose was to attempt to infer the vertical distribution of water vapor at high altitudes from solar transmission spectra.	Completed; preliminary transmission spectra delivered to ARM; future activities to be scheduled as requested
4/94; 5/95; 6/95	ARM UAV Demonstration Flight 2 (UDF-2)	J. Vitko (SNL); G. Stokes (PNL)	J. Liljegren	Measurements of clear-sky flux profiles acquired by a UAV and surface support data are to be used to understand clear-sky heating rates and the ability of models to reproduce the observations.	First IOP conducted successfully in April 1994; planning underway for September 1995
9/94-10/94; 6/95-7/95	Sampling of Coherent Structures with the 915-MHz Profiler	R. Coulter (ANL)	R. Cederwall	Fluctuations in the vertical wind and index of refraction are observed by operating the 915-MHz profiler with RASS in a special mode during the afternoon hours to sample convective plume structures.	Scheduled
6/95-7/95	Surface Energy Exchange IOP	C. Doran (PNL); R. Coulter (ANL); R. Stull (UW)	R. Cederwall	Detailed observations of the temperature and moisture profiles in the PBL will be obtained within a radius of 75-125 km of the central facility by using airsondes, profilers, and sodars to evaluate the variations of the PBL structure in relation to underlying surface fluxes.	Design in progress

TABLE 5 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
9/95	ARESE	Collaborative	T. Cress	The purpose is to study the anomalous absorption of solar radiation by clouds. The phenomenon was first noticed when satellite measurements of solar radiation absorbed by the surface atmosphere were compared with solar radiation measured at co-located surface sites.	Design in process

[a] Affiliations: ANL, Argonne National Laboratory; CIMMS, Cooperative Institute for Mesoscale Meteorological Studies; CSU, Colorado State University; ETL, Environmental Technology Laboratory; GSFC, Goddard Space Flight Center; NASA, National Aeronautics and Space Administration; NCAR, National Center for Atmospheric Research; NCSU, North Carolina State University; NOAA, National Oceanic and Atmospheric Administration; NSSL, National Severe Storms Laboratory; PARC, Palo Alto Research Center; PNL, Pacific Northwest Laboratory; PSU, Pennsylvania State University; SNL, Sandia National Laboratories; UM, University of Massachusetts; UNAVCO, University NAVSTAR Consortium; UU, University of Utah; UW, University of Wisconsin; and WPL, Wave Propagation Laboratory.

[b] Other definitions: AERI, atmospherically emitted radiance interferometer; ARESE, ARM Enhanced Shortwave Experiment; CART, Cloud and Radiation Testbed; DSIT, Data and Science Integration Team; FDDA, four-dimensional data assimilation; GCIP, GEWEX Continental-Scale International Project; GEWEX, Global Energy and Water Experiment; GIST, GCIP Integrated Systems Test; GPS, global positioning system; IDP, Instrument Development Program; IOP, Intensive Observation Period; IR, infrared; IRF, instantaneous radiative flux; ISS, integrated sounding system; MSX, midcourse satellite experiment; PBL, planetary boundary layer; RASS, radio acoustic sounding system; SCM, single-column model; SGP, Southern Great Plains; UAV, unmanned aerospace vehicle; UDF-2, UAV Demonstration Flight 2; VORTEX, Verification of the Origins of Rotation in Tornadoes Experiment.

The IOPs and campaigns are, in general, proposed by Science Team members, ARM infrastructure staff, the site scientist, or the SAC to the DSIT. The DSIT integrates and develops specific requirements into a document that is passed on to the site program manager for evaluation, assessment, and budgetary consideration.

Three IOPS of key scientific interest during this planning period are discussed below.

The Summer 1995 Surface Energy Exchange (SEE) IOP. This IOP will examine variations in planetary boundary layer (PBL) structure and document how they are related to variations in the underlying surface fluxes. Following the IOP, observed surface fluxes will be used in a mesoscale model to evaluate whether the simulated structures in the PBL are in accordance with the IOP observations. Understanding and documenting how the PBL responds to surface fluxes is important for the evaluation of SCMs in the ARM Program. This IOP will use the surface heat and moisture flux data derived from the EBBR systems and will take advantage of any ECOR systems that are available during the IOP. Additional measurements expected within the SGP site in conjunction with this IOP will be from three daytime airsonde launch sites within 75-125 km of the central facility.

The Summer 1995 Single-Column Model (SCM) IOP. An SCM is essentially a physical parameterization package extracted from a general circulation model (GCM) or other large-scale model. The SCM is a primary test of our current understanding of the clouds and radiative transfer. The SCM IOPs are designed to provide, as boundary conditions, the advective tendencies and vertical velocities that are the dynamic forcing normally calculated with a GCM. The BBSS is the only technology currently capable of providing the range and resolution of observations of the winds and thermodynamic quantities necessary to estimate these boundary conditions. Because of the necessity for derivatives in both horizontal directions, BBSS data from the central facility and the four boundary facilities are the minimum required to provide reliable estimates.

The ARM Enhanced Shortwave Experiment (ARESE) IOP. The ARESE IOP is motivated by recent field measurements that have brought into question the present understanding of shortwave absorption by clouds, suggesting that clouds absorb shortwave radiation in amounts that would be of great significance in atmosphere models but are not now represented in these models. These observations indicate the need for further examination of the absorption of solar radiation by the atmosphere, both theoretically and experimentally, because major potential consequences are associated with uncertainties in the present understanding of atmosphere-cloud-radiation interactions.

The ARESE IOP will be conducted to measure the absorption of solar radiation by the clear and cloudy atmosphere. The experimental results will be compared with model calculations. Measurements will be made from three aircraft platforms (the DOE high-altitude testbed, here represented by the Egrett; an instrumented Twin Otter, in stacked configuration, provided by the unmanned aerospace vehicle (UAV) program; and the NASA ER-2 aircraft), as well as from satellites and the ARM central and extended facilities in north central Oklahoma. The project will occur over a four-week period, beginning on September 22, 1995. Spectral broadband, partial-bandpass, and narrow-bandpass (10-nm) solar radiative fluxes will be measured at different altitudes and at the surface to determine directly the magnitude and spectral characteristics of the absorption of shortwave radiation by the atmosphere (clear and cloudy). Narrow spectral channels selected to coincide with absorption by liquid water and ice will help in identifying the process of absorption of radiation. Other information needed as input in calculations of radiative transfer, such as water vapor, temperature and ozone profiles, aerosol optical depths, cloud structure, liquid water path and phase, will be acquired by using CART surface facilities in addition to aircraft.

4.2 Design of Intensive Observation Periods

The initial design of most special operations will be in the hands of the DSIT. Prototype procedures to facilitate the design, review, and implementation processes are required for planning IOPs. Examples of such plans were included in Appendices A and B of Schneider et al. (1993). Similar documents are being prepared by the Campaign Team leader to facilitate interagency collaborations and by the Operations Team leader to facilitate the use of guest instruments. The SST will assist the DSIT in the generation of plans for special operations; will include the plans for newly approved QMEs, IOPs, and campaigns in the *Site Scientific Mission Plan;* and will assist in the execution of special operations. With the many-month lead time necessary to schedule research aircraft, the design of special operations involving aircraft should begin more than one year before the projected operation and should be sufficiently complete to be included in collaborative proposals.

4.3 Data Quality and Quality Measurement Experiments

In response to the movement of the boundary facilities (because of interference with the NOAA profilers) and the addition of the fourth boundary facility, the quality of BBSS data was evaluated (M. Leach and J. Yao, unpublished information). Analysis indicated that both activities have led to an improvement in the BBSS data quality. Reduction in the interference resulting from the move has led to a 15-20% increase in the number of sondes with scientific utility, and the additional BBSS system at Purcell has led to a 10% reduction in errors associated with the calculation of analyzed fields such as divergence and advective tendencies. The improvements are of special benefit to the SCM group.

Dew formation on and condensation in the EBBR net radiometer dome has been noted by site operators. A study presented at the March 1995 Science Team Meeting (Splitt and Wesely 1995) indicated that problems associated with radiometer data (in comparisons between the SIROS and EBBR net radiometer data) are probably due to the observed dew and condensation on EBBR domes. On the basis of those results, the vendor has been contacted regarding design changes. Advisories and recommendations to the Science Team concerning the affected data will be pursued simultaneously with an investigation of operational remedies.

As part of the data quality assurance effort, our focus needs to go far beyond the calibration of instruments to intercomparison of data streams and to evaluations of our ability to capture an accurate representation of the state of the atmosphere. Quality measurement experiments (QMEs) are investigations designed to enhance the ARM data quality by providing information derived from a continuous intercomparison of alternative measurements or models of observed geophysical quantities. The results of QMEs are documented and provide information about data quality that is intended to be "known and reasonable." These efforts are spearheaded by the instrument mentor, the DSIT, and the SST; however, suspect data can be reported to ARM by anyone via the Problem Review Board, which is made up of representatives from all of the ARM Program functional groups that meet weekly. The Board's function is to review any problem associated with data and to assign appropriate personnel to resolve the problem. During this six-month period, a high priority will again be comparison of similar data streams from different instrument packages, a natural and obvious complement to the efforts of the instrument mentors. A number of QMEs developed by instrument mentors, the SST, or the DSIT will be conducted by employing routine observations.

Examples of QMEs include the currently running comparisons of (1) the AERI spectral radiances and the values calculated via the line-by-line radiative transfer model (LBLRTM) and (2) the integrated columnar water vapor measured by the microwave radiometer (MWR) and that calculated from the vertical integration of water vapor estimates from the BBSS. Prospective QMEs include comparison of (1) water vapor profiles retrieved from the MWR with the BBSS moisture profile; (2) the brightness temperatures observed by the MWR with values calculated by using the LBLRTM at the specific wave numbers at which the MWR operates; (3) cloud base heights derived from the BLC and MPL with cloud base heights derived from other cloud radars as available; (4) the observed to calculated broadband radiative surface fluxes; (5) virtual temperature and velocity profiles from the BBSS with data from the 915- and 50-MHz profilers; (6) temperature, humidity, and pressure measurements from the SMOS with those from the 60-m tower and the EBBR system; and (7) momentum, heat, and moisture fluxes derived from the EBBR with those from ECOR systems. Many of these studies that are under consideration would help to evaluate the vendor-specified operating ranges, precision, and accuracy of the CART instruments.

The newly created Value-Added Products Working Group is intended to provide a mechanism for generating scientifically useful data (including products from QMEs) for geophysical quantities that are important to the ARM Program, including the SGP site. Value-added products are second-generation data streams derived by using existing data streams as input and applying algorithms to them. This working group is composed of various scientists from the DSIT, IT, and SST. The group is dedicated to data quality issues and will prioritize the creation of products focused on key geophysical quantities and facilitate the implementation of procedures to generate such products. The results of these efforts, including the results of QMEs, will have both short- and long-term effects on the ARM data stream and on site management, including advisories to the Science Team concerning data quality, modifications in strategies for data acquisition, and reassessments of measurement algorithms. The most important and unique of the instrument comparisons will be distributed as internal ARM reports and submitted for publication in appropriate journals.

4.4 Support for the Instrument Development Program, Guest Instruments, and Campaigns

The SGP CART site is an ideal location for rigorous field tests of new observational systems and has been designed to support these activities with a minimum of disruption to the continuous observations. The AERI is capable of routine detection of IR radiances with high spectral resolution and accuracy and will be essential to experiments exploring the effects of greenhouse gases, clouds, and fine particles on atmospheric transmission, absorption, and emission. More AERIs are scheduled for later deployment at the SGP boundary facilities, where the AERIs will be used to infer vertical profiles of temperature and humidity below the cloud base. The global positioning system (GPS) can be used to measure total water vapor in the atmosphere; it was tested successfully at the SGP CART site. The GPS effort was not funded by ARM but was hosted by the site as a guest instrument. The SGP CART site is also a logistically friendly base for early tests of the ARM UAV (April 1994 and 1995), a platform that figures prominently in plans for future oceanic CART sites. The ARM UAV program is a self-standing sister program of ARM CART. The ARM UAV program will be involved with the ARESE IOP in September 1995.

4.5 Campaign Planning

Table 6 summarizes potential campaigns and cooperative projects that have been called to the attention of CART site management. Plans for these activities are in various stages of development, and the topics are listed briefly here to generate further discussion. Inclusion in this list does not imply any endorsement of these activities by the ARM Program.

Except for some special hydrologic measurements, the GEWEX Integrated System Test (GIST) observations will be limited to currently operational observation networks and the SGP data. The GIST participants have expressed a strong interest in scheduling their field work simultaneously with our spring and summer SCM IOPs.

4.6 Educational Outreach

The educational outreach program for the SGP CART site, coordinated by Dr. Ken Crawford, Director of the Oklahoma Climate Survey (OCS), will combine a range of resources available at the University of Oklahoma. Outreach efforts will be focused at the precollege, undergraduate, and graduate levels. Efforts in this six-month period will focus on integration of ARM data (as nearly in real time as possible) into the EARTHSTORM project, a program conducted by the OCS to integrate real-time data into classroom activities in kindergarten through grade 12 (McPherson and Crawford 1995). The EARTHSTORM project currently accesses data from the Oklahoma Mesonet, a high-density network of surface meteorological stations, and provides it to students in real time. EARTHSTORM has created learning modules

TABLE 6 Collaborative Campaigns and Activities under Discussion

Title[a]	Proponent/Contact[b]	Projected Date
GEWEX		
GCIP	J. Leese	1995-1996
ISLSCP	P. Sellers	1995-1996
GVaP	H. Melfi	Spring 1996
GCSS	M. Moncrieff	To be determined
Soil Moisture and Temperature Profiling	J. Schneider (NSSL)	1995-1997
WB-57 Overflights	J. Liljegren	As requested
CASES (boundary layer and hydrology facility)	W. Blumen (CU)	1995-1996
Gulf Moisture	To be determined	To be determined
MSX Satellite	T. Cress	1995

[a] CASES, Cooperative Atmosphere-Surface Exchange Site; GCIP, GEWEX Continental-Scale International Project; GCSS, GEWEX Cloud Study System; GEWEX, Global Energy and Water Cycle Experiment; GVaP, GEWEX Water Vapor Project; ISLSCP, International Satellite Land-Surface Climatology Project; MSX, midcourse satellite experiment.

[b] Affiliations: CSU, Colorado State University; CU, Colorado University; and NSSL, National Severe Storms Laboratory.

and has provided teacher workshops to enhance the use of Mesonet data. Extension of these activities to ARM data can occur after regular data transfer to the project is established. Extension of these efforts to the Tropical Western Pacific and the North Slope of Alaska ARM sites will be investigated.

5 DISTRIBUTION OF DATA

As mentioned in Section 2, the DSIT is grouping the measurements required by Science Team proposals in terms of the four GMS categories. In addition, the Experiment Center has begun to track data requests, particularly individuals who have requested data and the number of responses being delivered weekly. This section integrates these two activities by grouping the users of the data into IRF, SCM, DA, HD, IDP, and miscellaneous categories. Figure 4 reflects the status of experiment operations plans (EOPs) (from which the DSIT identifies the data streams required) since the first data were released from the SGP CART site.

Most of the data being requested are received from the SGP CART site or external data sources and are then repackaged for weekly distribution to the individual users. In some cases, the user can log into the Experiment Center and extract data (by anonymous File Transfer Protocol [FTP]). Since January of 1995, 50 data streams have been fully released. An additional 20 data streams are being released at the beta level.

The information presented in Figure 4 indicates that the IRF category has the largest number of users receiving data. This number is large because the central facility instrumentation addresses nearly all of the platform requirements of the IRF, and the central facility is nearly complete. More and more platforms will be available as boundary facilities are more fully developed and as the number of extended facilities increases.

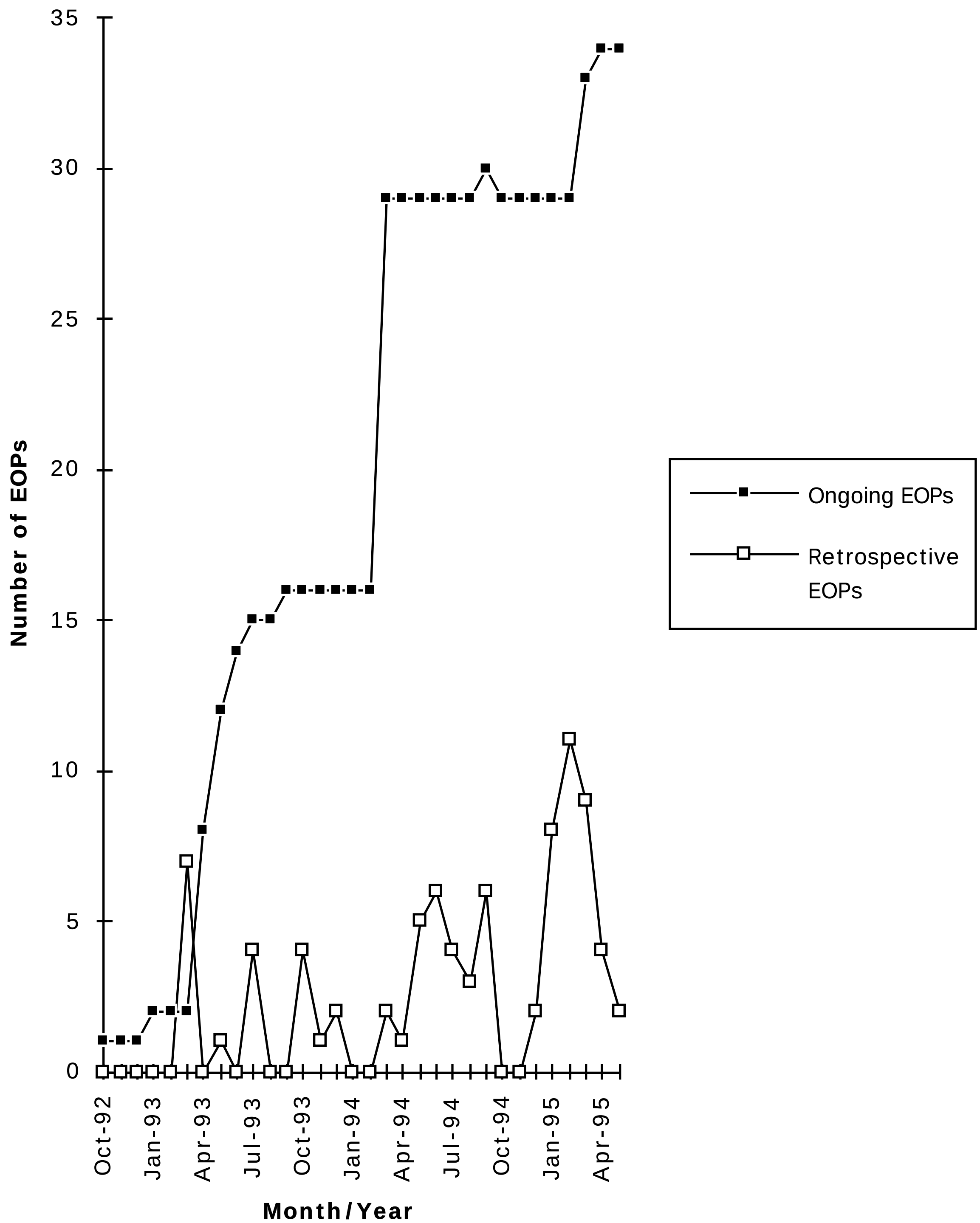

FIGURE 4 Status of Ongoing and Retrospective Experiment Operations Plans

6 LOOKING AHEAD

As indicated in earlier sections, although budgetary limitations and delays in procurement have somewhat slowed the development and completion of the SGP CART site, a strong effort is now underway to achieve site completion. Thus, by the end of 1995, the site will be essentially complete and providing a significantly wider range of data streams. The data, in turn, will support substantial enhancement of the DSIT's value-added products and will showcase data set development for, and Science Team research by, all four GMS groups.

Two anticipated or recent developments at the central facility are worthy of particular note. First, the expected enhancement by December 1995 of some of the basic instrumentation at the central facility (e.g., the day-night WSI and the improved AERI) will support a more complete specification of the radiative state of the near-surface atmosphere. This specification will be valuable to many IRF Science Team members, particularly if it is complemented by the development of a procedure to document accurately the temperature and water vapor distributions in the lowest 200 m of the atmosphere. The development of the latter capability, which is presently under consideration, was strongly urged by participants in the September 1994 IRF Workshop at the University of Maryland. Furthermore, the addition of PAR and UV-B instruments will support ecology studies. Second, the June 1995 installation of the ECOR systems at the central facility will permit more complete characterization of the turbulent transfers of heat and moisture at the central facility. The EBBR fluxes currently determined at the central cluster are representative of the pasture at the central facility. The ECOR fluxes are characteristic of the wheat fields at the central facility. In addition, the delivery of the portable ECOR system in early 1996 will establish a capability to compare independent flux measurements at the central and extended facilities against measurements by a single system.

By the end of 1995, the development of procedures for spatial integration of turbulent and radiative fluxes will be facilitated by the establishment of all or nearly all of the planned extended facilities (depending on delivery of instrumentation). Any remaining extended facilities will be completed in early 1996. These extended facilities will all have recently calibrated EBBR systems and SIROS units. In addition, the full establishment and operation during early 1996 of three intermediate facilities containing 915-MHz profilers (with RASS) will enhance the SGP CART site's capability to observe the PBL.

Despite substantial previous progress, the central facility will still lack several important observing systems and facilities by December 1995. The planned installation of the permanent

CART Raman lidar in early 1996, following initial IDP operations this fall, is eagerly anticipated, particularly by the IRF Science Team members. Such optimism reflects the potential of this state-of-the-science instrument to characterize the atmosphere (e.g., water vapor, clouds, and aerosols) more accurately and with finer vertical resolution than the existing suite of instruments (radiosondes and microwave radiometers) can. The September 1994 IRF Workshop recommended that "the specification of the atmospheric state at the central facility be accomplished from the combined Raman lidar and RASS. The ARM Program must plan on a rapid implementation of these remote sensing technologies." Further contributing to this specification will be temperature and humidity profiles that will be routinely produced from AERI instrumentation at the central facility. The vigorous pursuit of this exciting opportunity would place the ARM Program in the international vanguard by diminishing the dependence of the atmospheric science community on the radiosonde for thermodynamic profiling of the troposphere. Full realization of this opportunity will require improved wind profiler observations.

Another central facility observing system that will be installed during the first half of 1996 is the IDP millimeter cloud radar. This instrument will be equipped to map the vertically extent of cloud boundaries up to a height of approximately 20 km. Measurements of vertical wind speed will be made by Doppler analysis. The system will operate only in the vertically pointing position. The addition of the cloud radar will enhance the ongoing efforts of the Value-Added Products Working Group to improve the definition of cloud characteristics (fractional coverage, as well as base and top heights) above the central facility in coordination with key Science Team members.

The SGP CART activities during 1996 will capitalize on the late 1995 installation of the aerosol instrumentation and the RCF. The data from the associated suite of aerosol instruments will fill a significant gap in the specification of the radiative state of the near-surface atmosphere. The establishment of the RCF is a key element in the total quality control effort for the wide variety of radiometers at the central facility. Establishment of the RCF will be accompanied in late 1995 or early 1996 by the development and implementation of the comprehensive, integrated calibration plan that is required as the SGP CART site moves from the *establishment* of routine operations to the *maintenance* of routine operations, with inherent instrument-aging problems.

During 1996 and 1997, the SGP CART observational capabilities will be further enhanced as a result of ongoing interactions between the ARM Program and several other federal and state research programs having an interest in the SGP CART site. At present, these interactions particularly involve the GCIP component of GEWEX. They have already resulted in the formation and functioning of a joint ARM-GCIP Working Group (on which ARM is represented by C. Doran, R. G. Ellingson, and P. J. Lamb), the funding by GCIP of additional SGP CART radiosonde observations during August 1994, and the implementation during the next two years of a network to profile soil moisture and temperature. The joint working group will be concerned with suggesting observational strategies for the SGP CART site for 1996 and 1997. Beyond that, the working group will benefit both programs by fostering the most cost-effective and efficient operations program possible. The GCIP funding of additional radiosonde soundings may continue (and perhaps be enhanced) during 1996 and 1997. In addition, the GCIP component of NOAA's Climate and Global Change Program is now supporting the SST's development of a capability at the central facility and all extended facilities to profile soil moisture and temperature for the total SGP CART domain, fulfilling the needs of both ARM and GCIP. Approximately one-third of the planned network will be installed and will become operational in late 1995, with the remaining sites being established during 1996 and 1997. This important enhancement of the observational capabilities of the SGP CART site will strongly complement the ARM extended facilities in their central role of facilitating the spatial integration of surface heat, moisture, and momentum exchanges across the SGP CART domain. This vital surface and subsurface characterization of the SGP CART site is expected to be further enhanced during 1996-1998, when the Oklahoma Mesonet deploys identical equipment for profiling soil moisture and temperature at half of its 110 statewide locations, approximately 25 of which will lie within the SGP CART site. This Mesonet effort, being funded by the National Science Foundation, will be very closely coordinated with the installation of the ARM-GCIP network by the SST. Finally, the need for SGP CART observations and the resulting research to be related to NASA's Earth Observing System (EOS) activities is recognized; such interaction will be pursued.

Somewhat less formal interactions with the Verification of the Origins of Rotation in Tornadoes Experiment (VORTEX) program, which were initiated early 1994, are expected to continue in 1996. These interactions led to funding by VORTEX of an enhancement of the spring 1994 SGP CART radiosonde observations and to joint aircraft operations during the spring 1995 IOP. This joint aircraft observational capability stemmed from a collaborative proposal to NOAA's Environmental Research Laboratories (ERL) that was prepared by SST and VORTEX personnel. Aircraft-based instruments measured the following parameters: upwelling and downwelling microwave brightness temperatures at low, middle, and high altitudes; upwelling and downwelling narrowband solar radiances above, in, and below clouds; cloud liquid water content; and in-cloud long-path extinction. Joint analysis of the resulting data sets is expected to extend into at least the first half of 1996. The dividends likely to accrue to the ARM Program would include improvement of inhomogeneous cloud models, an initial assessment of an ARM ergodic hypothesis (that time-series measurements of cloud optical depth can be used to infer the instantaneous horizontal distribution of optical depth), and improved retrievals of total precipitable vapor and cloud water path from special-sensor, microwave-imager data. Such findings will be reflected in the subsequent planning and execution of SGP CART observational strategies.

The integration of ARM UAV operations into the SGP CART scientific missions was initiated successfully during the April 1994 IOP by using a small UAV (GNAT) that can ascend only to 6.7 km (~22,000 ft). Delays in developing and testing the larger UAVs needed for radiation measurements at higher elevations will likely delay further ARM UAV operations until 1996. Those operations, to be supported by climatological analysis by the SST of historical cloud and tropospheric wind data from the SGP CART site, may include a dedicated UAV IOP.

One especially important involvement of the UAV program in ARM will occur during the ARESE IOP, which is scheduled for September-October 1995 and is described in Section 4.1. Because no large UAV is available, a slow-flying single-engine aircraft (Grob Egrett) will perform the functions originally planned for the UAV. The ARESE IOP is a rapid response to the discovery that absorption of solar radiation by clouds may be significantly greater than was previously thought. The early interpretations of the data involved (satellite top-of-the-atmosphere measurements and land and ocean surface measurements of radiation) suggest that existing climate models may underestimate the global mean absorption of solar radiation by clouds by as much as 25-40 W m^{-2} and may incorrectly assign that absorption to the surface. If it is ultimately substantiated, this finding would require significant rethinking of our understanding of atmospheric heating and may render previous estimates of climate warning even more uncertain than has been thought. The principal contributors to this effort to date (R. D. Cess, F. Valero, V. Ramanthan, J. Kiehl, and others) concluded that the SGP CART facility is ideally suited as a location for an experiment to quantify the processes involved. The ARESE IOP will obtain diverse radiative flux data from ground-based (central and extended facility), satellite, and other aircraft platforms (Twin Otter and NASA's ER-2), as well as from the Egrett. The experiment will also be supported by analysis by the SST of historical cloud and storm frequencies.

Although the ARESE IOP will be conducted during the six-month period covered by this plan, it will likely have a significant effect on subsequent SGP CART operations. First, the successful conduct of the ARESE IOP will convincingly demonstrate the ability of the SGP CART site to mount focused (including pilot) observational programs at relatively short notice, and it could attract other such programs in the future. Second, the analysis of the ARESE data, which will begin in late 1995 and continue throughout 1996, may necessitate fine tuning of, and perhaps more major modifications to, the routine procedures for SGP CART observations of radiative flux and clouds. Subsequent smaller-scale, highly focused IOPs may be needed to address critical issues that emerge from the fall 1995 data. The opportunity for the SGP CART site to play a central role in this important experiment will be of considerable benefit to the overall ARM Program.

By December 1995, the scientific operation of the SGP CART site will have begun to benefit from guidance provided by the SAC. The fundamental role of the SAC will be to ensure that the operations of the site address the goals and objectives of the ARM Program (now being embodied in a formal *Science Plan*) to the fullest possible extent, including successful adaptation to changing circumstances and opportunities. Such performance will ensure that the flows of data to the Science Team members are appropriate to their needs, of consistently high quality, and as continuous as possible. Because the membership of the SAC will be divided approximately equally between Science Team members and nonmembers, its guidance should reflect both the inherently more parochial concerns of the Science Team members and the broader global-change perspective of the others.

The continued increase in SGP CART site and allied operations during the rest of 1995 and 1996, coupled with a parallel enhancement of the ability of the SDS to handle the resulting data streams, is expected to result in a mature pursuit of the scientific mission of this ARM locale by mid 1996. The increase in operations should greatly facilitate the Science Team's use of the SGP CART data in an interactive, near-real-time mode during 1996. One of the most unique potentials of the ARM Program will thus be more fully realized.

7 REFERENCES

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APPENDIX A:

ACQUISITION AND DEPLOYMENT

OF INSTRUMENTS

TABLE A.1 Status of Instrument Acquisition and Deployment on June 30, 1995[a]

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
WSI	Thorne	Done	Done	7/95	None planned	None planned	An additional WSI will be installed at an auxiliary facility in 1996.
MWR	Liljegren	Done	Done	Done	None planned	Done	—
IR thermo-meter	Liljegren	Done	Done	Done	None planned	None planned	For use with the MWR.
BBSS	Lesht	Done	Done	Done	None planned	Done	—
EBBR	Cook	Done	Partial	Done	10 units installed; 3 more in fall	None planned	Instrument changeouts for calibration implemented summer 1995.
915-MHz RASS	Coulter	Done	1 unit; 3 more in 1996	Done	None planned	None planned	Additional units to be placed midway between central and boundary facilities.
50-MHz RASS	Coulter	Done	Done	Done	None planned	None planned	—
SMOS	Hart	Done	Done	Done	9 units installed; 6 more in fall 1995	None planned	—
BLC	Campbell	Done	Done	Done	None planned	None planned	—
MPL	Griffin	Done	Done	7/95	None planned	None planned	—
Raman lidar	Goldsmith	Done	9/95	Summer 1996	None planned	None planned	—
Calibration facility	Stoffel	Done	11/95	12/95	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
60-m tower	Cook	Done	Done	Done	None planned	None planned	—
ECOR	Hart, Cook	Done	Done	Done	4 installed; 8 more in summer 1996	None planned	—
Soil water and temperature systems	Wesely, Schneider	Done	Partial	1 installed in fall 1995	7 installed in fall 1995; 15 more by spring 1997	None planned	—
Aerosols							
Manifold sample system	Leifer	Done	Con-structed at EML	9/95	None planned	None planned	—
Ozone monitor	Leifer	Done	At EML	9/95	None planned	None planned	—
Optical absorption system	Leifer	Done	At EML	9/95	None planned	None planned	—
3-λ integrating nephelo-meter	Leifer	Done	At EML	9/95	None planned	None planned	—
1-λ integrating nephelo-meter	Leifer	Done	At EML	9/95	None planned	None planned	—
Optical particle counter	Leifer	Done	At EML	9/95	None planned	None planned	—
Conden-sation particle counter	Leifer	Done	At EML	9/95	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Broadband Radiometers: SIROS							
MFRSR	Schmelzer, Larson	Done	Partial	Done	10 installed; 23 by 12/95	None planned	—
Broadband radiometer loaners (ARM BSRN)	DeLuisi	Done	Done	Done	None planned	None planned	QME planned to compare ARM BSRN with SIROS.
Pyrano-meter (ventilated)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	—
Pyrano-meter (upwelling 10 m)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	—
Shaded pyrano-meter (ventilated)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	SciTec trackers and shading assemblies in use beginning 1/95.
Pyrgeo-meter (shaded and ventilated)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	SciTec trackers and shading assemblies in use beginning 1/95.
Pyrgeo-meter (upwelling 10 m)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	—
Pyrhelio-meters (NIP)	DeLuisi	Done	Partial	Done	10 installed; 23 by 12/95	None planned	SciTec trackers and shading assemblies in use beginning 1/95.
Other Radiometric Instruments							
UV-B sensor	DeLuisi	Done	Done	10/95	None planned	None planned	—
PAR	DeLuisi	Done	Done	10/95	None planned	None planned	—

TABLE A.1 (Cont.)

Instrument	Mentor	Ordered	Delivered	Central Facility Installation/ Acceptance	Extended Facility Installation/ Acceptance	Boundary Facility Installation/ Acceptance	Comment
Pyranometer for 60-m tower	DeLuisi	Done	Done	Done	None planned	None planned	—
Pyrgeometer for 60-m tower	DeLuisi	Done	Done	Done	None planned	None planned	—
UV spectrometer	IDP/SUNY Albany	IDP in progress	Fall 1995	Fall 1995	None planned	None planned	—
Rotating shadowband radiometer	IDP/SUNY Albany	IDP in progress	Fall 1995	Fall 1995	None planned	None planned	—
AERI	Griffin, Best	In progress	Partial	10/95	None planned	Four in fall 1996	First boundary facility installation to occur at Vici.
AERI X	Griffin, Murcray	No	No	Winter 1996	None planned	None planned	—
SORTI	Griffin, Murcray	In progress	Winter 1996	Winter 1996	None planned	None planned	—
Special IR broadband radiometer	None assigned	None	Unknown — unmet measurement	Unknown	None planned	None planned	—
MFR for upwelling at 10 m and 25 m	Schmelzer, Larson	Done	Done	Done	None planned	None planned	—

[a] AERI, atmospherically emitted radiance interferometer; ARM BSRN, ARM Program Broadband Solar Radiation Network; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; EML, Environmental Measurements Laboratory; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; PAR, photosynthetically active radiometer; QME, quality measurement experiment; RASS, radio acoustic sounding system; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SUNY, State University of New York; UV, ultraviolet; WSI, whole-sky imager.

TABLE A.2 Status of Radiometric Calibration Facility on May 31, 1995

Component	Mentor	Procurement Status	Delivery	Site Installation/ Acceptance	Comments
Calibration trailer (shell)	Stoffel	Done	Done	Installed	Not equipped
Reference spectroradiometer	Cannon	Done	To NREL[a]	Fall 1995	Response: 300-1100 nm
Extended wavelength spectroradiometer	Cannon	On hold	TBD[b]	TBD	Response: 300-3000 nm
Site reference cavity radiometer	Stoffel	Done	To NREL	Fall 1995	NREL calibration checks, fall 1993 and fall 1994
Program reference cavity radiometer	Stoffel	Done	To NREL	Accepted	NREL calibration checks, fall 1993 and fall 1994; primary location, NREL
Site working-standard cavity radiometer	Stoffel	Done	To NREL	Fall 1995	NREL calibration checks, fall 1993 and fall 1994; window installed
Atmospheric optical calibration system/reference sunphotometer	Cannon	On hold	TBD	TBD	Part of spectral capability
Automatic solar trackers	Stoffel	Specifications being written; order June 1995	To NREL	Fall 1995	Nine for SGP; two for NREL
Large solar tracker	Stoffel	On hold	TBD	TBD	For spectral measurements
Reference diffuse pyranometers	Stoffel	Specifications complete; order June 1995	Summer 1995	Summer 1995	—
Working standard pyranometers and pyrheliometers	Stoffel	Specifications complete; order June 1995	Summer 1995	Winter 1995	Control and measurement pyrheliometers; assurance units
Silicon pyranometers and pyrheliometers	Stoffel	Specifications complete; order June 1995	Summer 1995	Winter 1995	—

TABLE A.2 (Cont.)

Component	Mentor	Procurement Status	Delivery	Site Installation/ Acceptance	Comments
Working-standard pyrgeometers	Stoffel	Specifications complete; order June 1995	Summer 1995	Winter 1995	—
NIST standard lamps[c]	Stoffel	Done	Done	TBD	At NREL
Controlled current source for lamps	Stoffel	On hold	TBD	TBD	Control NIST lamps
Reference blackbody	Stoffel	Specifications to be written; order July 1995	Fall 1995	Winter 1995	—
Optical breadboard system	Stoffel	On hold	TBD	TBD	Specifications complete
Data acquisition system for broadband radiometry	Stoffel	Done	May 1995	Winter 1995	Functional tests completed at NREL May 1995
Data acquisition system for pyrgeometer calibration	Stoffel	Specifications in progress; order July 1995	Fall 1995	Winter 1995	—

[a] NREL, National Renewable Energy Laboratory.

[b] TBD, to be determined.

[c] NIST, National Institute of Standards and Technology.

TABLE A.3 Future Instruments[a]

Future Instruments (IDP)	IDP Investigator/Mentor	Procurement	IDP Testing
Ultraviolet spectral radiometer	Harrison	No	Fall 1995
Rotating shadowband spectroradiometer	Michalsky, Harrison	No	Fall 1995
SORTI[b]	Murcray, Griffin	Summer 1995	Fall 1995
Net radiometric profiler	Whiteman	No	Not scheduled yet
Raman lidar	Goldsmith, Griffin	SOW,[c] late 1993	Fall 1995
Cloud radar	Moran, Widener	SOW, fall 1994	Fall 1995
Microwave water vapor profiler	Unknown	Unknown	Unknown

[a] Includes IDP instruments.

[b] SORTI, solar radiance transmission interferometer.

[c] SOW, statement of work.

APPENDIX B:

OBSERVATIONS, MEASUREMENTS,

AND EXTERNAL DATA

TABLE B.1 CART Observation Status on June 30, 1995[a]

Observation	Platform	Comments
From the BBSS		
Sonde temperature profile	sgpsondewrpnC1.al	Available[b]
Sonde relative humidity profile	sgpsondewrpnC1.al	Available
Sonde pressure profile	sgpsondewrpnC1.al	Available
Sonde wind speed profile	sgpsondewrpnC1.al	Available
Sonde wind direction profile	sgpsondewrpnC1.al	Available
Recalculation of research mode pressure, temperature, and humidity without ground check applied to data for the period 4/8/94 to 5/20/94	DsgpsondeptucalcC1.c1 DsgpsondeptucalcB1.c1 DsgpsondeptucalcB4.c1 DsgpsondeptucalcB5.c1	Available Available Available Available
Recalculation of research mode pressure, temperature, and humidity with ground check applied to data for the period 4/8/94 to 5/20/94	DsgpsondenogcptucalcC1.c1 DsgpsondenogcptucalcB1.c1 DsgpsondenogcptucalcB4.c1 DsgpsondenogcptucalcB5.c1	Available Available Available Available
Removal of ground checks from nominal pressure, temperature, and humidity variables for the period 5/21/94 to 8/3/94	DsgpsondenogcwrpnC1.c1 DsgpsondenogcwrpnB1.c1 DsgpsondenogcwrpnB4.c1 DsgpsondenogcwrpnB5.c1	Available Available Available Available
From the MWR		
Column-integrated precipitable water vapor	sgpmwrlosC1.al	Available
Column-integrated liquid water path	sgpmwrlosC1.al	Available
23.8-GHz brightness temperature	sgpmwrlosC1.al	Available
31.4-GHz brightness temperature	sgpmwrlosC1.al	Available
IR (9.5-11.5 µm) sky temperature	sgpmwrlosC1.al	Available
From the AERI		
Wave number (520-1800 cm^{-1})	sgpaerich1C1.al	Available
Mean IR radiance spectra ensemble	sgpaerich1C1.al	Available
Standard deviation of spectra ensemble	sgpaerich1C1.al	Available
Wave number (1800-2725 cm^{-1})	sgpaerich1C1.a1	Available
Mean IR radiance spectra ensemble	sgpaerich1C1.al	Available
Standard deviation of spectra ensemble	sgpaerich1C1.al	Available
Mean IR radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaerisummaryC1.al	Available
Standard deviation of the radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaerisummaryC1.al	Available
Brightness temperature at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaerisummaryC1.al	Available
From the EBBR (at Ten Sites)		
Sensible heat flux to surface	sgp30ebbrE4.al	Available
Latent heat flux to surface	sgp30ebbrE4.al	Available

TABLE B.1 (Cont.)

Observation	Platform	Comments
From the EBBR (at Ten Sites) (Cont.)		
Net radiation flux to surface	sgp30ebbrE4.al	Available
Soil heat flux to surface	sgp30ebbrE4.al	Available
Top and bottom temperatures	sgp30ebbrE4.al	Available
Top and bottom relative humidities	sgp30ebbrE4.al	Available
Top and bottom vapor pressures	sgp30ebbrE4.al	Available
Atmospheric pressure	sgp30ebbrE4.al	Available
Soil moistures at five points	sgp30ebbrE4.al	Available
Soil temperatures at five points	sgp30ebbrE4.al	Available
Scalar and resultant wind speeds	sgp30ebbrE4.al	Available
Mean and standard deviation of wind direction	sgp30ebbrE4.al	Available
From the SMOS (at Five Sites)		
Mean and standard deviation of wind speed	sgp30smosE4.al	Available
Mean and standard deviation of wind direction	sgp30smosE4.al	Available
Vector-averaged wind speed	sgp30smosE4.al	Available
Mean and standard deviation of temperature	sgp30smosE4.al	Available
Mean and standard deviation of relative humidity	sgp30smosE4.al	Available
Vapor pressure	sgp30smosE4.al	Available
Mean and standard deviation of barometric pressure	sgp30smosE4.al	Available
Snow depth	sgp30smosE4.al	Available
Precipitation total	sgp30smosE4.al	Available
From the ARM BSRN		
Direct beam-normal solar irradiance	sgpbsrnC1.a1	Available
Downwelling hemispheric diffuse solar irradiance	sgpbsrnC1.a1	Available
Downwelling hemispheric solar irradiance	sgpbsrnC1.a1	Available
Downwelling hemispheric IR irradiance	sgpbsrnC1.a1	Available
From the SIROS		
Direct beam-normal solar irradiance	sgpsirosE131.al	Available[c]
Downwelling diffuse solar irradiance	sgpsirosE13.al	Available[c]
Downwelling hemispheric solar irradiance	sgpsirosE13.al	Available[c]
Upwelling hemispheric solar irradiance	sgpsirosE13.al	Available[c]
Upwelling hemispheric IR irradiance	sgpsirosE13.al	Available[c]
Downwelling hemispheric IR irradiance	sgpsirosE13.al	Available[c]
Hemispheric downward solar irradiance (415, 500, 610, 665, 862, and 940 nm)	sgpsirosE13.al	Available[c]
Hemispheric downward total solar irradiance	sgpsirosE13.al	Available[c]
Diffuse hemispheric downward solar irradiance (415, 500, 610, 665, 862, and 940 nm)	sgpsirosE13.al	Available[c]
Diffuse hemispheric downward total solar irradiance	sgpsirosE13.al	Available[c]
Direct beam-normal solar irradiance (415, 500, 610, 665, 862, and 940 nm)	sgpsirosE13.al	Available[c]
Direct beam-normal total solar irradiance	sgpsirosE13.al	Available[c]

TABLE B.1 (Cont.)

Observation	Platform	Comments
From the BLC		
Cloud base height	sgpblcC1.c1	Available
From the Profiling Radars		
915-MHz wind speed profile	sgp915rwpwindC1.a2	Available[c]
915-MHz wind direction profile	sgp915rwpwindC1.a2	Available[c]
915-MHz virtual temperature profile	sgp915rwptempC1.a2	Available[c]
50-MHz wind speed profile	sgp50rwpwindC1.a2	Available[c]
50-MHz wind direction profile	sgp50rwpwindC1.a2	Available[c]
50-MHz virtual temperature profile	sgp50rwptempC1.a2	Available[c]
Other Systems		
Interim WSI	sgpwsicloudC1.c1	Available[c]
60-m tower temperature and relative humidity	sgp30twr21x.C1 sgp1twr21x.C1 sgp1440twr21x.C1	Available
Upwelling MFR at 10 m (tower)	Dsgpmfr10mC1.a1	Available[c]
Upwelling MFR, precision solar pyranometer, and precision IR radiometer at 25 m	Dsgpmfr25mC1.a1	Available[c]
From Future Instruments		
Cloud base height (MPL)	DsgpmplcbhC1.c1	IDP testing in 1995
Ultraviolet spectral radiometer	—	IDP testing in 1995

[a] AERI, atmospherically emitted radiance interferometer; ARM BSRN, ARM Program Broadband Solar Radiation Network; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; EBBR, energy balance Bowen ratio; IR, infrared; MFR, multifilter radiometer; MPL, micropulse lidar; MWR, microwave radiometer; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; WSI, whole-sky imager.

[b] "Available" means that an instrument is in the field producing some level of data. Normally, the data have been fully released by the instrument mentor.

[c] Beta release to select users.

TABLE B.2 CART Measurement Status on June 30, 1995[a]

Measurement	Platform	Comments
From the ARM BSRN		
Direct beam-normal solar irradiance	sgpbsrncalcC1.c1	Available[b]
Calculated downward hemispheric diffuse solar irradiance	sgpbsrncalcC1.c1	Available
Downwelling hemispheric solar irradiance	sgpbsrncalcC1.c1	Available
Solar zenith angle used in calculation	sgpbsrncalcC1.c1	Available
From the SIROS		
Optical depth (spectrally resolved)	DsgpsirosdepthC1.a1	Available
Solar constant (spectrally resolved)		
From the MWR		
Average (5-min) column-integrated water vapor	sgp5mwravgC1.c1	Available
Average (5-min) column-integrated liquid water	sgp5mwravgC1.c1	Available
Average (5-min) blackbody equivalent brightness temperature	sgp5mwravgC1.c1	Available
Water vapor density profile	sgpmwrprofC1.c1	Not available[c]
From the SIROS MFRSR		
Optical depth (415, 500, 610, 665, 862, and 940 nm)	sgpsirosopdepthC1.c1	Available
Solar constant (415, 500, 610, 665, 862, and 940 nm)	sgpsirosopdepthC1.c1	Available
Optical depth calculation standard error (415, 500, 610, 665, 862, and 940 nm)	sgpsirosopdepthC1.c1	Available
From Science Team Algorithms		
Reflected solar flux at top of atmosphere (TOA) (Cess algorithm)	toa-refflx	Available
Input for LBLRTM	lblrtm.input	Available
Output from LBLRTM (IR spectral irradiance at 520-3020 cm^{-1})	lblrtm.output	Available
Difference of observations and calculations of IR irradiances	qme-aerilbldiff	Available
Map of wave number to physical process	qme-MLSspecmap	Available
Statistical summary of radiance residuals	qme-aerilbl	Available
Statistical summary of hourly AERI radiance	qme-aerimeans	Available

[a] AERI, atmospherically emitted radiance interferometer; ARM BSRN, ARM Program Broadband Solar Radiation Network; IR, infrared; LBLRTM, line-by-line radiative transfer model; MFRSR, multifilter rotating shadowband radiometer; MWR, microwave radiometer; SIROS, solar and infrared radiation observing system; TOA, top of atmosphere.

[b] Available means that an instrument is in the field producing some level of data; however, the data may not have been released by the instrument mentor or the Experiment Center and thus may not be available to the Science Team members.

[c] Water vapor density profile algorithm under revision; new measurement available by July 1995.

TABLE B.3 CART External Data Status on June 30, 1995[a]

Measurement	Platform	Comments
From Satellites		
AVHRR channel 1 "albedo," channel 2 "albedo," channel 3 brightness temperature, channel 4 brightness temperature, channel 5 brightness temperature, satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpavhrr12X1.a1	Available[b]
AVHRR radiances: channel 3 calibrated radiances and channel 4 calibrated radiances	sgpavhrr12radX1.a1	Available
GOES visible: visible channel "albedo," satellite zenith angle, solar zenith angle, and satellite-solar azimuth angle	sgpgoes7radX1.a1	Available
GOES IR: channel 5 IR brightness temperatures, channel 12 IR brightness temperatures, satellite zenith angle, solar zenith angle, and satellite-solar azimuth angle, and channel 5 calibrated radiances	sgpgoes7visX1.a1	Available
GOES radiances: channel 5 calibrated radiances and channel 12 calibrated radiances[c]	sgpgoes7irX1.a1	Available
GOESIR8: channel 8 IR brightness temperatures, satellite solar zenith angle, solar zenith angle, and satellite-solar azimuth angle	sgpgoes7ir8X1.a1	Available
GOES radiances: channel 8 calibrated radiances	sgpgoes7rad8X1.a1	Available
From GOES Data		
GOES derived products: cloud amount (low, medium, and high), visible optical depth (low, medium, and high), IR optical depth (low, medium, and high), emissivity (low, medium, and high), cloud center height (low, medium, and high), cloud top height (low, medium, and high), cloud temperature (low, medium, and high), cloud thickness (low, medium, and high), reflectance (low, medium, and high), albedo (low, medium, and high), cloud center temperature (low, medium, and high), cloud top temperature (low, medium, and high), visible optical depth standard deviation (low, medium, and high), cloud center temperature standard deviation (low, medium, and high), broadband longwave flux (clear sky and total), narrowband IR flux (clear sky and total), broadband shortwave albedo (clear sky and total), narrowband visible albedo (clear sky and total), clear temperature, clear temperature standard deviation, narrowband visible albedo standard deviation, clear visible reflectance, and solar zenith angle	sgpgoesminnisX1.c1	Available
From the Forecast Systems Laboratory MAPS Model		
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 kPa from the surface to 100 kPa, covering most of North America (subsets also available)	sgpallmaps60X1.c1	Available

TABLE B.3 (Cont.)

Measurement	Platform	Comments
From the Forecast Systems Laboratory MAPS Model (Cont.)		
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 kPa from the surface to 100 kPa, covering most of the SGP CART site	sgpmaps60X1.c1	Available
Derived variables from Mesoscale Analysis and Prediction System (MAPS) data similar to those in ngm250derived	sgpmaps60derivX1.c1	Available
From the Arkansas-Red River Basin Forecast Center		
Hourly precipitation estimates for an area much larger than the SGP CART site, at 4-km resolution	sgpabrfcpX1.c1	Available
From the National Meteorological Center ETA Model		
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 kPa from the surface to 100 kPa, covering most of North America (subsets also available)	sgpalleta90X1.c1	Available[d]
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 kPa from the surface to 100 kPa, covering most of the SGP CART site	sgpeta90X1.c1	Available[d]
Horizontally averaged values, derived from eta90 data, of surface pressure (reduced to sea level), tropopause pressure, and surface temperature	eta90derived	Available[d]
Slab-averaged vertical profiles, derived from eta90 data, of temperature (T), -(u*dT/dx + v*dT/dy), water vapor mixing ratio (q), -(u*dq/dx + v*dq/dy), horizontal wind components (u and v), (du/dx + dv/dy), -(u*du/dx + v*du/dy), - (u*dv/dx + v*dv/dy), and geopotential height (Z), dZ/dx, dZ/dy, d2T/dx2, d2T/dy2, d2q/dx2, d2q/dy2, d2u/dx2, d2u/dy2, d2v/dx2, d2v/dy2	eta90derived	Available[d]
From the NOAA Wind Profiler Demonstration Network		
Profile of hourly consensus wind components	sgp60wpdnwndsX1.b1	Available
Profile of 6-min moments of wind components	sgp06wpdnmmtsX1.a1	Available
Hourly surface observations	sgp60wpdnsurfX1.00	Available
From the NWS		
Surface hourly observations	sgpnwssurfX1.b1	Available
Upper air observations	sgpnwsupaX1.b1	Available

TABLE B.3 (Cont.)

Measurement	Platform	Comments
From the Kansas Surface Mesonetwork		
Daily observations of maximum air temperature, minimum air temperature, total precipitation, total solar radiation, maximum 5-cm soil temperature, minimum 5-cm soil temperature, maximum 10-cm soil temperature, minimum 10-cm soil temperature, average relative humidity, maximum relative humidity, minimum relative humidity, mean wind speed, resultant wind speed, resultant direction, standard deviation of direction, and maximum (fastest minute) wind speed	sgpksudlymesoX1.b1	Available
From the Oklahoma Mesonetwork		
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (15-min average)	sgp15okmX0.a0	Available
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (5-min average)	sgp05okmX0.a0	Available

[a] AVHRR, advanced very-high-resolution radiometer; GOES, geostationary orbiting Earth satellite; IR, infrared; MAPS, Mesoscale Analysis and Prediction System; NOAA, National Oceanic and Atmospheric Administration; NWS, National Weather Service.

[b] Available means that an instrument is in the field producing some level of data; however, the data may have not been released by the instrument mentor or the Experiment Center and thus may not be available to the Science Team members.

[c] The GOES infrared channels may vary with the schedule for use at a particular time.

[d] Available over the World Wide Web from NASA-ARM home page: http://albedo.larc.nasa.gov:1123/arm.html

TABLE B.4 Observational Instruments and Systems Expected to Be in Place at the Central and Boundary Facilities by December 31, 1995[a]

Central Facility

Radiometric Observations

- AERI
- SORTI
- SIROS
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded[b])
  - Pyrgeometer (ventilated, shaded[b])
  - NIP on tracker
  - MFRSR
  - Pyranometer (upwelling, above pasture at 10 m)
  - Pyrgeometer (upwelling, above pasture at 10 m)
- MFR (upwelling, above pasture at 10 m)
- Pyranometer (upwelling, above wheat at 25 m on 60-m tower)
- Pyrgeometer (upwelling, above wheat at 25 m on 60-m tower)
- MFR (upwelling, above wheat at 25 m on 60-m tower)

Wind, Temperature, and Humidity Sounding Systems

- BBSS
- 915-MHz profiler with RASS
- 50-MHz profiler with RASS
- MWR
- Heimann IR thermometer
- SMOS
- EBBR
- ECOR

Cloud Observations

- Day-night WSI[b]
- Belfort laser (interim) ceilometer
- MPL (IDP) ceilometer

Instruments and Systems in the Aerosol Trailer

- Optical absorption system[b]
- Integrating nephelometer (1 λ)[b]
- Integrating nephelometer (3 λ)[b]
- Optical particle counter[b]
- Condensation particle counter[b]
- Ozone monitor[b]
- Manifold sample system[b]

Instruments and Systems in the RCF

- Solar spectroradiometer[b]
- Site reference cavity radiometer[b]
- NIST standard lamps with controlled current source[b]
- Optical breadboard system[b]
- Controlled current source[b]

Others

- Temperature and humidity probes at 60 m on tower
- ECOR systems near surface[b]
- ECOR systems on 60-m tower[b]

TABLE B.4 (Cont.)

Extended Facility Components

SIROS
- Pyranometer (ventilated)
- Pyranometer (shaded, ventilated)
- Pyrgeometer (shaded, ventilated)
- NIP on tracker
- MFRSR
- Pyranometer (upwelling, at 10 m)
- Pyrgeometer (upwelling, at 10 m)

SMOS
EBBR
ECOR systems

Boundary Facilities

BBSS
MWR

Auxiliary Facilities

None are in preparation.

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[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; NIST, National Institute of Standards and Technology; RASS, radio acoustic sounding system; RCF, radiation calibration facility; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; WSI, whole-sky imager.

[b] Added after September 1994.

TABLE B.5 CART Measurements and External Data Expected to Be in Place by December 31, 1995[a]

Radiation

Point AERI downwelling IR radiance
Point MFRSR global, diffuse, direct solar narrowband irradiance
Point pyrgeometer downwelling global IR irradiance
Point pyrgeometer upwelling global IR irradiance
Point pyranometer downwelling global solar irradiance
Point pyranometer upwelling global solar irradiance
Central downwelling 10-µm radiance
Reflected solar flux at top of atmosphere
Point IR (9.5-11.5 µm) sky temperature
Satellite clear-sky reflectance
Satellite clear-sky-equivalent blackbody temperature
AVHRR visible "albedo," narrowband radiances and brightness temperatures[b]
VISSR atmospheric sounder visible "albedo," narrowband radiances and brightness temperatures[c]
Site 2-D grid of surface downwelling solar radiative flux
Site 2-D grid of surface upwelling solar radiative flux
Site 2-D grid of surface downwelling IR radiative flux
Site 2-D grid of surface upwelling IR radiative flux
Site average surface downwelling solar radiative flux
Site average surface upwelling solar radiative flux
Site average surface downwelling IR radiative flux
Site average surface upwelling IR radiative flux

Temperature

Central sonde vertical profile of temperature
Boundary sonde vertical profile of temperature
NWS sonde vertical profile of temperature
Extended 3-D grid of temperature
Site vertical profile of slab-averaged temperature
Site vertical profile of slab-averaged advective temperature tendency

Pressure

Central sonde vertical profile of pressure
NWS sonde vertical profile of pressure
Extended 3-D grid of pressure
Extended 3-D grid of pressure surface heights
Site vertical profile of sonde-derived pressure gradient
Site vertical profile of RASS-derived pressure gradient

Water Vapor

Central inferred vertical profile of water vapor density
Central sonde vertical profile of relative humidity
Central sonde vertical profile of WVMR

TABLE B.5 (Cont.)

Water Vapor (Cont.)

NWS sonde vertical profile of relative humidity
Point MWR column-integrated "total precipitable" water vapor
Extended 3-D grid of WVMR
Site vertical profile of slab-averaged sonde WVMR
Site vertical profile of slab-averaged advective WVMR tendency

Winds and Dynamics

Central vertical profile of vertical wind components
Point sonde vertical profile of horizontal wind components
NWS sonde vertical profile of horizontal wind components
Extended 2-D grid of surface horizontal wind components
Extended 3-D grid of horizontal wind components
Site vertical profile of slab-averaged horizontal wind components
Site vertical profile of slab divergence of horizontal wind
Site vertical profile of slab-averaged advective momentum tendency
Site vertical profile of vertical velocity
Site vertical profile of geostrophic wind components

Trace Gases

Central surface ozone concentration

Aerosols

Central derived surface visibility
Central surface aerosol size distribution
Central surface aerosol absorption and scattering coefficient at 550 nm
Central vertical profile of ceilometer relative aerosol backscatter

Cloud Bulk Morphology and Distribution

Central ceilometer cloud base height
Central whole-sky image
Horizontal cloud distribution
Central fractional cloud cover
Cloud spacing
Cloud thickness
Site fractional cloud cover
Site cloud base height
Cloud top temperature (radiative)
Cloud base temperature (radiative)
NWS/USAF cloud fraction (by layer)
NWS/USAF cloud type (by layer)
NWS/USAF cloud base (by layer)
Cloud base height
Satellite-derived cloud amount
Satellite-derived cloud top temperature

TABLE B.5 (Cont.)

Cloud Bulk Morphology and Distribution (Cont.)

Satellite-derived cloud top height
Satellite-derived cloud center temperature
Satellite-derived cloud center height
Satellite-derived cloud thickness

Cloud Microphysics and Precipitation

Point MWR total cloud liquid water
Central vertical profile of phase of water
Point SMOS precipitation rate
Point NWS precipitation rate
Point Kansas Mesonet precipitation rate
Point Oklahoma Mesonet precipitation rate
Site 2-D grid of precipitation rate
Site total column cloud water

Cloud Optical Properties

Cloud albedo
Satellite-derived cloud reflectance
Satellite-derived cloud albedo
Satellite-derived visible optical depth
Satellite-derived IR optical depth
Satellite-derived IR emissivity
Satellite-derived narrowband IR flux
Satellite-derived broadband longwave flux

Clear-Sky Properties

Satellite-derived narrowband IR flux
Satellite-derived broadband longwave flux
Satellite-derived narrowband visible albedo
Satellite-derived broadband shortwave albedo
Satellite-derived albedo temperature

Near-Surface Meteorology

Point SMOS near-surface temperature
Point flux station near-surface temperature (two levels)
Point NWS near-surface temperature
Point Oklahoma Mesonet near-surface temperature
Point Kansas Mesonet near-surface temperature
Point SMOS near-surface pressure
Point flux station near-surface pressure
Point NWS near-surface pressure
Point Oklahoma Mesonet near-surface pressure
Point Kansas Mesonet near-surface pressure
Point SMOS near-surface relative humidity
Point flux station near-surface relative humidity

TABLE B.5 (Cont.)

Near-Surface Meteorology (Cont.)

Point NWS near-surface relative humidity
Point Oklahoma Mesonet near-surface relative humidity
Point Kansas Mesonet near-surface relative humidity
Point SMOS near-surface horizontal wind components
Point flux station near-surface horizontal wind components
Point NWS near-surface horizontal wind components
Point Oklahoma Mesonet near-surface horizontal wind components
Point Kansas Mesonet near-surface horizontal wind components
Extended 2-D grid of near-surface temperature
Extended 2-D grid of near-surface pressure
Extended 2-D grid of near-surface WVMR
Site average near-surface temperature
Site average near-surface pressure
Site average near-surface WVMR
Site average near-surface horizontal wind components
Point-derived PBL depth
Central capping inversion depth
Site average PBL depth

Surface Fluxes

Point flux station surface sensible heat flux
Point flux station surface moisture flux
Point flux station surface momentum flux
EBBR surface net radiation flux
EBBR surface latent heat flux
EBBR ground heat flux
Site 2-D grid of surface sensible heat flux
Site 2-D grid of surface moisture flux
Site 2-D grid of surface momentum flux
Site average surface sensible heat flux
Site average surface moisture flux
Site average surface momentum flux

Surface Properties

Point-derived broadband surface albedo
EBBR soil moisture
Gridded surface conditions
Site 2-D grid of surface roughness
Site 2-D grid of surface albedo
Site average surface albedo
Site average surface roughness
Site ground surface type
Site average surface WVMR
Site average ground temperature

TABLE B.5 (Cont.)

Quality Measurements
Comparison of observed and calculated IR irradiance
Comparison of observed and calculated microwave brightness temperatures
Comparison of MWR and sonde precipitable water
Comparison of surface net radiation estimates
Comparison of surface heat flux estimates
Comparison of cloud base estimates

[a] AERI, atmospherically emitted radiance interferometer; AVHRR, advance very-high-resolution radiometer; EBBR, energy balance Bowen ratio; GOES, geostationary orbiting Earth satellite; IR, infrared; MFRSR, multifilter rotating shadowband radiometer; MWR, microwave radiometer; NWS, National Weather Service; PBL, planetary boundary layer; RASS, radio acoustic sounding system; SMOS, surface meteorological observation station; USAF, U.S. Air Force; VISSR, visible-IR spin-scan radiometer; WVMR, water vapor mixing ratio; 2-D, two-dimensional; 3-D, three-dimensional.

[b] On polar-orbiting satellites.

[c] On geostationary satellites (GOES).